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AUTOMATIC SIGNALS ON THE LOCOMOTIVE are to be introduced on the Chicago & Eastern Illinois R. R., between Dolton and Momence, Ill., 33 miles. This will include the equipment of 51 locomotives. The Miller system, which has been adopted for this installation, has been in experimental use for some months on a length of six miles of track of this road between Chicago Heights and Thornton Junction, only one engine, however, being equipped. The line will be divided into block sections of suitable length, and adjacent block sections are separated by an insulated track section one rail in length. The track batteries are placed at these points, the positive wire being connected to the insulated rail, and the negative wire to the rail of the block section in the rear. The rails of each block are bonded in the usual way. In the engine cab are two incandescent signal lamps, one white (or green) and the other red. One or other of these is always burning. Current is supplied by a battery on the engine or tender, and is switched from one lamp to the other by an instrument operated by the track circuit. Each axle has electrical connection with a conductor leading to the instrument on the engine. When the wheels enter the insulated section (if the "stop" signal is to be given) the current passes from the rail through the wheel, conductor and cab instrument, switching the lighting circuit to the red lamp. The signal is always given two blocks back from the obstructed block, or the train-order signal, so that when the red lamp burns the engineman knows that he has one clear block in which to stop his train. The red signal burns when a switch is open, a block section occupied, or a train-order signal displayed. This system was invented by Wr. H. V. Miller, Superintendent of Telegraph of the Chicago & Alton Ry., and is being introduced by the Miller Signal Co., 1031 Monadnock Block, Chicago, which has the contract for the installation on the Chicago & Eastern Illinois R. R.

DISK OR SOLID CENTER WHEELS are not to be used in future on the Atlantic type of fast passenger engines on the New York Central R. R. Disk wheels with solid wrought-iron centers and Krupp tires were used on the first engines, illustrated in our issue of Aug. 8, but we learn from Mr. A. M. Waitt, Superintendent of Motive Power & Rolling Stock, that he has issued instructions to the American Locomotive Co. to the effect that future engines of this type must have spoke-center steel-tired wheels.

THE ACT TO REGULATE RAILWAY GRADE CROSSings in Texas, which was passed at the last session of the State Legislature, became operative on July 9, and the State Railroad Commission, whose duty it is to enforce the law, has issued a call for a general hearing on Oct. 1, at which the question of requiring the railways operating within the state, to provide interlocking or other safety devices at all crossings will be considered. The three principal sections of the new law are as follows:

(1) That where it should become necessary for the track of one railroad company to cross the track of another railroad company, it shall be the duty of the Railroad Commission of the state of Texas to ascertain and define by its decree the mode of such crossings which will occasion the least probable injury upon the rights of the company owning the road which is intended to be crossed; and if it should appear to the said commission that it is reasonable and practicable to avoid a grade crossing said commission shall, by its order, prevent same.

(2) That in any case where the tracks of two or more railroads cross each other at a common grade in this state, it shall be the duty of such railroad company to protect such crossings by interlocking or other safety devices of equal security to prevent trains colliding at such crossings, and such interlocking or other safety devices or applicances and regulations to be designated by the Railroad Commission of Texas, to prevent trains colliding at such crossings, provided that all railway companies in this state shall have one year after the passage of this bill in which to comply with the provisions hereof.

(3) In case any railway company shall hereafter seek to cross at grade with its track or tracks the track or tracks of another railroad, the railroad seeking to cross at grade shall be compelled to interlock and protect such crossings by safety devices to be designated by the Railroad Commission, and to pay all cost of appliances, together with the expense of putting them in, provided that this act shall not apply to the crossing of side tracks.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the Chesapeake & Ohio R. R., on Aug. 15, near Norwood, Va. One person was killed and two were injured.

SERIOUS TROLLEY CAR ACCIDENTS are reported from a number of places. On Aug. 17, a trolley-car collision with a passenger train on the Long Island R. R., resulted in the deaths of two persons and the injury of 22 others, all passengers of the trolley car. The collision occurred on the section of track between Kensington Junction and Parkville Junction, about one-half mile long, which is used by both the electric cars of the Brooklyn Rapid Transit Co., and by the railway trains of the Long Island R. R. The electric car met the passenger train head on at full speed and was demolished, scattering the passengers in all directions. The cause of the accident is claimed to have been neglect on the part of the motorman to obey the signals. The motorman was one of the two who were killed outright.——On Aug. 18 two cars on the New York & Queens County Electric road crashed together and injured many members of an outing party. The accident was due, it is said, to the temporary darkening of the first car while the conductor changed the trolley pole connection, the motorman of the second car being unable to see the first car through the heavy downpour of rain. ——At Kansas City, Mo., on Aug. 18, one person was killed, one fatally injured and another seriously injured by a trolley car crashing into a carriage at Seventh and Delaware Sts. The victims were in the carriage. They had stopped to allow the car to pass, when a runaway team crashed into the carriage and shoved it in front of the car, which was going at full speed.——A collision between a trolley car on the 47th St. line in Chicago and a passenger train on the Pittsburg, Ft. Wayne & Chicago R. R., on Aug. 17, resulted in the death of four persons, and the injury of a number of others. The motorman lost control of his car, which ran through the safety gates and crashed into the second coach of the rapidly moving train.

THE SINKING OF THE STEAMER "ISLANDER," of the Canadian Pacific Alaskan Line, from collision with an iceberg off Douglas Island on Aug. 15, resulted in the death of 65 persons.

FIRE IN A TEMPORARY CRIB of the new Cleveland water-works tunnel, on Aug. 14, resulted in the death of some eight men by suffocation and drowning. A shift of eleven men were at work in the tunnel, near the bottom of the shaft, and some thirty other men were in the shelter on the crib, mostly asleep. The reports state that a boiler explosion was responsible for the fire. However that may be, it spread with such great rapidity that the men down the shaft could not come up and those on the crib had to jump into the lake. Most of the latter were rescued by boats from the shore. After the fire had been subdued nine of the eleven men in the tunnel were hauled up by ropes. The other two were given up as lost, but it is reported that they too were rescued after they had been imprisoned over five days. There were two serious explosions in the tunnel several years ago.

EXPLOSIONS IN THE NEW WATER-WORKS TUNnel at Cincinnati, O., are reported, but no loss of life is mentioned. It is thought that better ventilation and more care with the electric wires will obviate the danger. The tunnel is being built to connect the new purification works with the city pumping station.

PLANS AND SPECIFICATIONS for the Naval Station at Algiers, La., have been completed and bids will soon be asked for constructing the necessary works. The buildings for the new station comprise a blacksmith shop and foundry, a machine shop, a power house, an office building and several subsidiary structures. The blacksmith shop and foundry building is to be 60 × 224 ft. c. to c. of outside columns. It is to be one story high. Along one side is to be an awning of steel corrugated iron projecting 12 ft. from building. The main farming will be in 16-ft. bays. Over nine of these bays the roof will be carried by trusses having a span of 60 ft., four bays will be divided into a central span of 30 ft., with a 15-ft. lean-to at each side. The inside column will carry a 5-ton crane. The south bay of the building will be only half covered by a cupola shed. This building will have a second floor, and on it will be located the dynamos and fans used for the blacksmith's blast. The machinery shop building will be the largest of all the buildings. It will be two stories high. It will measure 66 ft. 10 ins. in width × 276 ft. 10 ins. in length. The steel frame will be built in 11 bays, their spans being 25 ft. c. to c. of columns. The brick work of the building will be carried on steel framing. The second story of the building will be supported by steel columns. The structure will rest on concrete piers which will be supported by piles. A 13-in. wall will divide this building into two parts. The power house in which will be generated the great supply of electricity which will be required in the machine shops and for lighting purposes will be a one-story brick building 87 ft. 6 ins. long by 40 ft. wide. In addition to the larger buildings two steel sheds 224 ft. long and 60 ft. wide will be built. These sheds will be annexes of the foundry and blacksmith shops. An elaborate system of steam and tram railway car tracks will run in and around all the buildings and out over the large twin bridges and wharf direct to the dry dock.

AN 80-TON FLOATING CRANE has been designed and built by the Royal Dutch Forge Co., of Leyden, Holland, for use on the Santos Harbor works. Its principal dimensions are: Length of vessel, 100 ft.; beam, 35 ft.; depth, 7 ft. 3 ins.; outward overhang of shear legs, 35 ft. 3 ins.; height of top of shear legs above water level, 50 ft. Power is supplied by a vertical high-pressure engine, with two cylinders, each 12 × 15 ins., and taking steam at a pressure of 120 lbs. The hoisting gear consists of two sets of wormwheel gearing and two sets of spurwheels. The worms, of forged steel, are driven from the steam engine. The wormwheels are fitted on intermediate shafts, on which, on the other end, are fixed cast-steel pinions, driving the cast-steel spurwheels bolted to the drums. Each drum, of cast iron, has a diameter of 3 ft. 7 ins. by a length of 3 ft. 7 ins. between the flanges, and weighs about 4 tons. All shafts are of forged steel; the bearings have large surfaces, and are lined with white metal. The shear legs are constructed of mild steel plates, the diameter in the middle being 2 ft. 8 ins. The upper ends of the shear legs are provided with cast-steel top pieces to take the upper shaft, which is of forged steel, 12 ins. in diameter. The water-ballast tank, having a capacity of 130 tons, is divided into four compartments. Each compartment can be filled separately, and also all compartments together by a duplex ballast pump, placed in the engine room. The hull of the vessel is built of mild steel, and special attention has been paid to the longitudinal stiffness of the vessel.

TWO NEW FERRY BOATS for the service of the Central Railroad of New Jersey in New York Harbor have recently been built at Wilmington, Del. These boats are double-decked, 200 ft. long, 65 ft. beam and 17 ft. 9 ins. deep. They are fitted with five watertight bulkheads and are provided with steam-steering machinery. Each boat is driven by a four-cylinder triple-expansion engine, receiving steam from three boilers.

NAMES FOR THE FOUR EAST RIVER BRIDGES at New York city are being sought by the American Scenic and Historic Preservation Society, which has recently awarded prizes for the best and second best lists in a competition which it has recently invited. The bridges to be named comprise the present New York & Brooklyn Bridge, the New East River Bridge now well on toward completion, and the so-called Third and Fourth East River bridges, the construction of which has just been begun. The list of names which was awarded the first prize was submitted by Miss Mary I. Smithson, of East Orange, N. J., who suggested that the present bridge be called the "Brooklyn" Bridge; that the New East River Bridge be called the "Manhattan" Bridge, while the newest structures should be named the "York" bridge and the "Queens" Bridge, respectively.

THE PROPOSED 21-FT. CHANNEL in the Sault Ste. Marie Canal will cost about $9,000,000, and it will thus outclass the Canadian canal, which is 18 ft. deep.

COAL EXPORTATIONS FROM THE UNITED STATES during the fiscal year just ended, as shown by the Treasury Bureau of Statistics, amounted to $32,317,496, against $19,502,813 in the fiscal year, 1900. The value of coal exportations from the United States has doubled since 1897, and nearly trebled in the decade. These figures relate to values. Measured by quantity the increase has been even greater, the exports in 1901 being 7,676,140 tons, against 2,399,039 tons in 1891, thus making the total exports of 1901 in quantity more than three times as much as in 1891. The United States now stands third in the list of coal exporting countries of the world. The coal export figures of the principal countries of the world in 1899 show that while Belgium slightly exceeded the United States in the total number of tons exported, her imports were more than one-half as great as her exports, making her net exportation of coal much less than that of the United States. The figures of coal exports during 1900 recently published by the British government show that the coal exports of the three principal coal-exporting countries—the United States, Germany and the United Kingdom—in 1900 were: United States, 7,558,000 tons; Germany, 18,055,000 tons; and United Kingdom, 58,405,000 tons.

THE NEW ELECTRIC ELEVATOR AT THE WASHINGTON MONUMENT.

The new electric elevator plant installed at the Washington Monument by the Marine Engine & Machine Co., of Harrison, N. J., replaces the original steam elevator installed by Otis Bros. & Co. at the time the monument was built to its present height of 555 ft. The old steam elevator had performed its daily work for 15 years without a single accident or any material repairs, and all its parts were in excellent condition when removed.

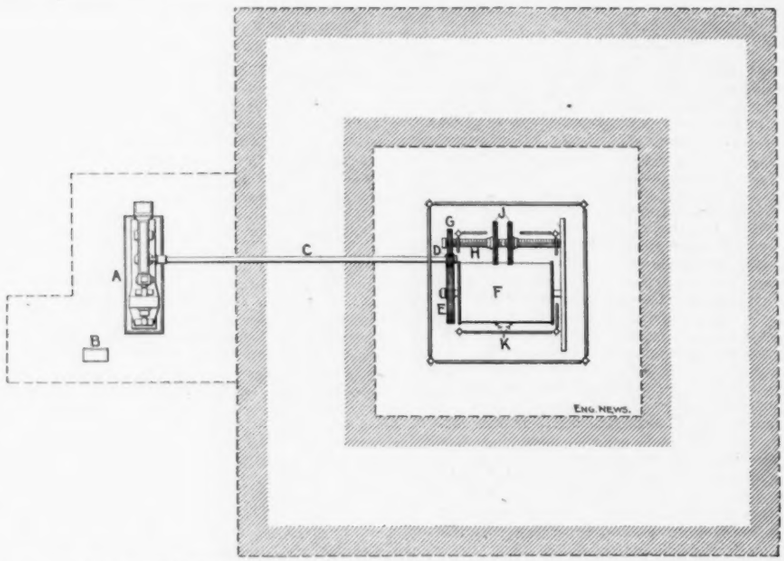

FIG. 1. PLAN OF ELECTRIC ELEVATOR INSTALLATION AT THE WASHINGTON MONUMENT.

It was a model of elevator engineering in its day, but its slow speed of about 50 ft. per min., and the great loss in transmission of the steam to the hoisting engine from the boilers 800 ft. distant, impelled the government to substitute a modern electric elevator plant which would increase the car speed, as well as the efficiency of the whole plant from the coal pile to the actual work done at the car. The original elevator car, with its safety devices, etc., weighed 6,500 lbs., and when loaded to its normal capacity of 6,000 lbs., the net load on the hoisting drum was 12,500 lbs.

The specifications issued by the government engineers for the new electric elevator called for the introduction of a counterweight system, to overbalance the effect on the hoisting drum of the car and a part of its load. The weight of the new car, together with its safety device, cage, etc., is 5,670 lbs., and the weight of the drum counterbalance installed is 8,040 lbs., leaving a net overbalance on the hoisting drum of 2,370 lbs. when the car is empty. With the maximum load of 6,000 lbs. in the car, the net load on the hoisting drum to be lifted by the machine is therefore 3,630 lbs. at 100 ft. per min., equivalent to 11 HP. in gravity work, as compared with 18.9 HP. in gravity work for the old car. The net result of the two systems compared is, that the load is lifted by the new elevator at double the car speed, with 58% of the energy required at the hoisting drum by the old elevator to lift the same live load, viz.: 6,000 lbs., at 50 ft. per min., one-half of the speed of the new elevator. The saving in power, together with the increased efficiency of the electric over the steam hoisting machine, enabled the government engineers to double the speed of the elevator with the same load and have power to spare to light the monument and grounds.

HOISTING MACHINE.

The hoisting machine drives the 72-in. winding drum through the medium of a 6-in. pinion shaft about 30 ft. long, extending through a tunnel under the base of the monument to the old engine room. On the monument end of this shaft there are 2 pinions of 13 teeth, 3-in. circular pitch by 7-in. face each, the teeth being staggered. These pinions mesh into similar gears that are bolted to one end of the winding drum and have 75 teeth.

Fig. 1 is an outline plan showing the location of the hoisting machine at the base of the monument, in which (A) is the hoisting machine, (B) the controller, (C) the 6-in. shaft, which at one end is coupled direct to one of the spiral gears and carries on the other end the pinion (D), which drives the spur gear (E) bolted to the drum (F). The pinion (D) also drives the spur gear (G), which is keyed to the idler screw shaft (H). On this shaft are carried the idler sheaves (J); these sheaves revolve on right and left-hand nuts, respectively, which are held from turning by guide bars that are guided on a T-rail below the screw. The sheaves are, therefore, forced apart and drawn together as the spur gear (G) is driven in one direction or another by the pinion (D). The drum (F), on which the two pairs of 1½-in. ropes are wound, is grooved right-hand on one-half and left-hand on the other half, and the spur gear (G) and pitch of the screw (H) is designed to cause the idler sheaves (J) to follow the lead of the ropes from the drum (F). The ropes that pass under the sheaves (J) lead to the counterweight. The other pair of ropes (K) lead to the car.

The drum is 72 ins. in diameter, 9 ft. long, and is grooved right and left for two 1½-in. ropes.

All of this apparatus, being in good condition and so located as to make it impracticable to remove and replace by any other mechanism, had to be retained and the new electric hoisting machine adapted to drive this drum at 5.3 revs. per min., to give a car speed of 100 ft. per min., which speed was considered by the government engineers to be as fast as the existing conditions at the monument would permit. The gear reduction of 13 to 75 teeth between the pinion shaft and winding drum, required the pinion shaft to be driven at 30.58 revs. per min. by the new electric hoisting machine.

The hoisting machine proper (see Fig. 2) is of the tandem worm gear type, with right and left-hand worms, forged on a worm shaft, driving spiral gears which mesh together. The worm shaft is direct-connected to a 35-HP. Crocker-Wheeler motor, multipolar type, having a special shunt field winding. The normal speed of the motor is 628 revs. per min., which gives a car speed of 100 ft. per min. Variation of the field strength will, however, give speeds both above and below the normal if required. The brake consists of a pulley keyed on the worm shaft, and two cast-steel brake levers holding wood shoes against the pulley. The brake is applied by a compression spring and released by an electro-magnet. The upper and lower-limit device is an improved type driven by the drum shaft, and utilizing the well-known "traveling nut" on a screw shaft to open the limit switches at both limits of car travel. The switches are returned to their normal positions by means of a weight instead of a spring. The centrifugal governor, driven by the worm shaft, operates at a determined speed, to cut off current supply to motor and apply brake.

CONTROLLING DEVICE.

The controller consists of three essential parts, viz.: The two reversing switches shown on the lower panel and the resistance regulator on the upper panel. The panels are of Tennessee marble mounted on an angle iron frame.

The reversing switches are of the usual type, consisting of a solenoid core, to which are attached the copper contact plates. The switches are closed by the core being drawn into the coil, and opened by gravity. Copper as well as carbon contacts of large carrying capacity are provided, all contacts being independently movable. All arcing takes place on carbon contacts, which "make" first and "break" last. The resistance regulator consists of a contact arm traveling over the contact plates to which the resistance grids are connected. The contact arm is connected by means of the rack and gear to the core of the solenoid. At the right of the gear is a small electro-mechanical brake which will hold the contact arm in any desired position as long as desired.

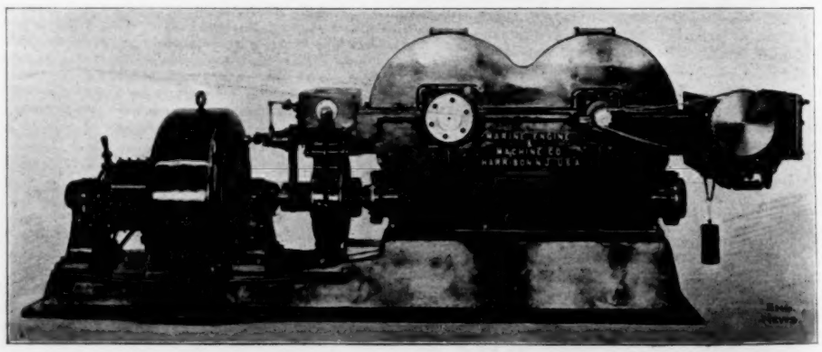

FIG. 2. WINDING MACHINE FOR ELEVATOR, BUILT BY THE MARINE ENGINE & MACHINE CO., OF HARRISON, N. J.

The broken lines indicate the outline of the base of the monument and the engine room, the floor of the engine room being about 12 ft. below the level of the base of the monument, and the shaft (C) passing through a tunnel between the engine room and the hoisting drum. This arrangement was obviously necessary, as there was no room inside of the base of the monument to place the hoisting machine; it, therefore, had to be located outside, in order not to disturb the foundation.

The coils of the regulator and brake magnet are connected in series when it is desired to raise the contact arm and "cut out" the resistance, thereby accelerating the motor. When it is desired to introduce the resistance into the motor circuit, the brake coil only is energized, releasing the brake and allowing the arm and core to return, by grav-

ity, to the position of all resistance in circuit. By manipulation of the operator's switch, the arm can be raised or lowered step by step as desired, giving variable car speeds from zero to maximum. Suitable switches, operated by the rack at both limits of travel, are provided to open the circuit of the regulator and brake coils and also to close the circuit to the "field relay" after all the start-

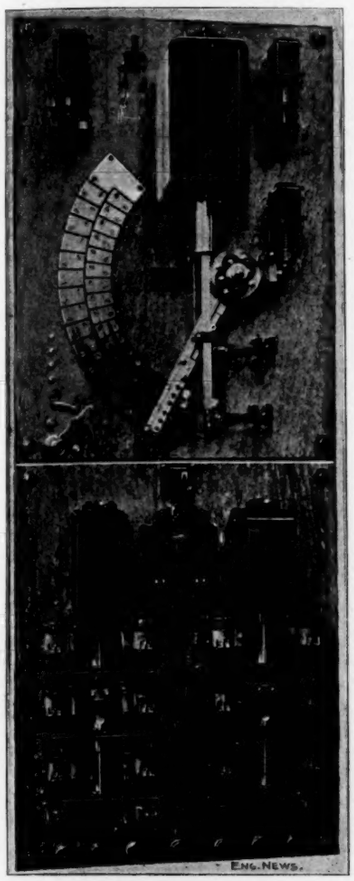

Fig. 3. Controller Switches of Elevator Motor.

ing resistance is cut out. This arrangement allows the operator to weaken the motor field, if he desires to increase the car speed, only under proper conditions. The field relay is shown in the upper left-hand corner of the panel. The small relay shown in the upper right-hand corner works in conjunction with the reversing switches to introduce resistance in series with their respective coils after the switches are closed and also to automatically return the resistance regulator to its normal starting position. The controller is also provided with an underload and overload circuit-breaker. The circuit of the underload coil runs to the elevator car, where a suitable switch is provided for the operator to open this circuit if desired. This switch also opens the machine brake circuit.

The operating device consists of a switch with suitable contacts for operating reversing switches on the controller, and to control the movements of the resistance regulator contact arm, and the field relay. A "slack cable switch" is also provided which operates to open the reversing switches and the circuit breaker, thereby stopping the motor. A switch, operated by the band brake on the winding drum, and connected in series with the slack cable switch, will produce the same result at the controller, should the band brake be applied for any reason.

COUNTERWEIGHT SYSTEM.

The counterbalance weighs 8,040 lbs., and is driven by two 1½-in. iron ropes attached to the opposite side of the drum from the hoisting ropes. The counterweight ropes lead up over a new sheave 58 ins. in diameter, and thence down to and under the two traveling idler sheaves which lead the ropes to the under side of the drum. These idler sheaves are 48 ins. in diameter, and run on a threaded shaft 8¾ ins. outside diameter, and 11 ft. 3½ ins. between bearings. The thread is single, 13-16-in. pitch. The shaft is driven by a gear with 35 teeth, meshing into the drum pinion. The idlers revolve on a traveling nut, thereby following the exact lead of the ropes from the drum. The rope grooves on the drum had to be extended by hand-cutting, to get a full turn for each counterweight rope. Counterweight ropes were not considered when the drum was originally designed, and there was just room enough to extend the grooves to the desired point. The idlers are of the largest diameter that could be installed in the space obtainable for them, and the cramped conditions existing about the winding drum, which is directly under the elevator hoistway, rendered the work of installing the necessary apparatus very difficult. New steel T-rails and supports for same were installed, to guide the counterbalance, which is 54 ins. between rails and 15 ft. 6 ins. over all.

The rope system is balanced by a chain counterbalance, weighing 3,550 lbs., one end of the chain being attached to the car and the other to the counterweight. The effect of this load on the steel structure of the monument had to be calculated and the supporting beams for the new counterweight sheave arranged in such a manner that the load would be distributed to the best advantage.

CAR AND SAFETY DEVICE.

The car frame and platform is of standard corner-post steel construction, with a platform 8 ft. 2 ins. × 9 ft. 4 ins. The car enclosure is of ornamental grill-work, finished in electro-bronze and lighted by a six-light electrolier. The safety device was required to operate on smooth steel rails, which made it necessary to remove the cast-iron racks used in connection with the old safety device, and to install in their place standard steel T-rails. The accompanying Fig. 4 shows three views of the safety attached to the steel channels underneath the elevator car, the jaws (n) in the bottom plan are shown set clear of the steel T-guide-rails. These jaws are pivoted to the outer ends of the two pairs of jaw levers (l), which are pivoted on pins (m). On the inner end of each of these jaws are a pair of rolls (k), and between each pair of rolls are a pair of wedges (h) and (j). The pair of wedges (h) at the right-hand of the safety are bolted to a bronze nut (d) mounted on the screw shaft (c). The wedges (j) at the left of the safety form the ends of rods (j'), that pass through the bronze nut (e) at the left-hand end of the screw shaft (c), and are tapped into the spring head (g), at the right-hand end of the main spring (f). Power to draw these two pairs of wedges together, force the rolls apart and force the jaws against the guide rails, is applied by the centrifugal governor, which is located at the top of the hoistway. An endless wire rope passes over its driving sheave, down under a tension sheave at the bottom of the hoistway, and a branch wire rope (b) spliced into it leads to the drum (a) that is shown fastened to the screw shaft (c). The action of the safety is as follows: The centrifugal governor, operating instantly the normal speed is exceeded, grips the endless rope and stops it, the continued travel of the car causes the drum (a) on the safety screw (c) to revolve, and the outer end of the rope (b) that is wound around it and fastened to the endless governor rope is now stopped. The safety screw (c) has now commenced to revolve, and its action upon the wedges through the medium of the main spring (f) is much more simple and effective in its operation than can well be described on paper; however, a careful attention to the following description may make the action clear.

This screw (c) has a right-hand thread on its right-hand end, and a left-hand thread on its left-hand end, thus drawing the two nuts (e) and (d) together as it is revolved in the proper direction to do so. As it advances through the left-hand nut (e) it forces a push bar (p) against a latch (q) that locks the toggles (r) together, which hold the main spring (f) compressed. Upon the release of this latch (q), the main spring (f) extends, forcing the left-hand pair of wedges (j), which are secured to the right-hand spring head (g), towards the right, and forcing the right-hand wedges (h), which are secured to the left-hand spring head (e), by means of the right-hand nut (d), screw (c), and left-hand nut (e) towards the left. In other words, this main spring (f) being unlatched, extends and draws the two pairs of wedges together, thus bringing the jaws (n) instantly in contact with the T-guide-rails (o), with sufficient pressure to check the speed of, but not enough to stop, the car. All this occurs before the car has traveled one foot after its normal speed has been exceeded. The further motion of the car continues to revolve the drum (a) and screw (c), and draw the right and left-hand nuts together, and now occurs the action that is altogether novel in elevator safeties. The jaws (n) have instantly gripped the rails (o), as in all spring safeties, and the main spring (f) is extended to its weakest working length, the continued revolutions of the screw (c) now drawing the two nuts together compress the main spring (f) until sufficient pressure is applied to the rails to stop the car, thus bringing the lightest or the heaviest load to a perfectly gradual and easy stop, and with practically unlimited power.

Should there be any doubt as to the reliability of the main spring (f), this safety would operate without its action, as other types of safeties do, by transmitting the action of the screw (c) positively to the wedges by means of the steel tube that is inside of the main spring (f), and acts as a stop or distance piece between the two spring

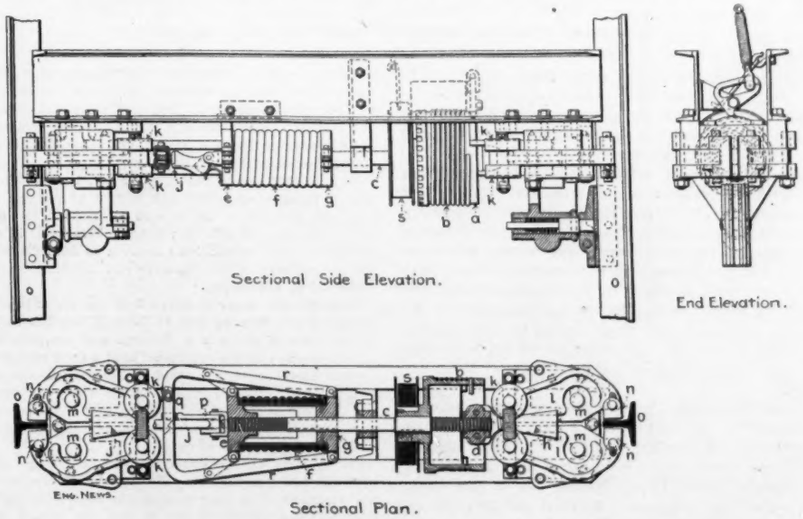

FIG. 4. SAFETY DEVICE ON ELEVATOR CAR.

heads. The release of this safety is effected simply by pulling on the governor rope from any part of the hoistway or from the car, and the flat spiral spring (s) winds up the screw (c) and automatically releases all working parts, ready for the next operation.

The object of this safety is to overcome several radical faults existing in other types of elevator car safeties, viz.: The use of wedges instead of toggle joints insures an equal pressure on both guide rails and prevents the danger of collapsing the car by stopping one side of it with more resistance than is applied to the other side; few cars are built to stand this strain. This, however, is a fault not common to all other types of safeties, as some of them use wedges similar to this. The fault that is common to all other safeties operating on steel rails is to apply the maximum gripping power with a sudden shock, either instantly the maximum speed is exceeded by means of a spring, or after the car has traveled far enough to take up the running clearance between the jaws and the guide rails. This action on a lightly-loaded car going at high speed is dangerous to life and limb, but there is further danger in connection with these devices. A safety grip applied by spring power only, uses, as before stated, the spring power at its weakest working extension, and its limited motion of spring renders it liable to become inoperative by wear of jaws and lack of proper adjustment. A safety grip applied by the travel of the car only, has to allow the car to travel free for a distance of from six to ten feet, before it grips the rails, which in the case of a free fall would attain a speed of from 1,200 to 1,500 ft. per min., at which speeds a stop in less than one foot distance might be fatal to both car and passengers.

In this safety it is seen that the spring used checks the speed of the car instantly, and finally stops the car by being gradually compressed up to the point of its maximum resistance, stopping all loads at any speed with practically unlimited power and perfect safety and comfort to the passengers. This safety can be operated from the car by a simple device that grips that part of the endless governor rope that travels in the opposite direction to the car. It can also be made to stop the car when going either up or down, if so desired.

Notwithstanding the engineering difficulties experienced in surveying the plant, designing the apparatus, estimating the friction losses in the old drum gears, shafts, sheaves and ropes, and the danger attending the installation of the work, the plant was completed without an accident or error. The guaranteed efficiency of the whole elevator system was 40% at the maximum load of 6,000 lbs., at 100 ft. per min. The test made by the government engineers under the above conditions showed an efficiency of 41.09% from the electrical energy delivered to the controller, to the actual work done at the car in lifting the load. In consideration of the friction losses in the heavy spur gearing at the drum, the long 6-in. pinion shaft, the two 48-in. idler sheaves mounted on an 8¾-in. screw shaft driven by the drum gears, and the loss due to driving two pairs of 1½-in. diameter iron ropes over their idler and overhead sheaves, this efficiency of 41.09% is high as compared with ordinary electric elevator installations. The efficiency of the elevator system as a whole is no doubt due to the high efficiency of the spiral worm gears in the hoisting machine which have the unusually steep angle of 15½°.

The entire work at the monument, including the new power plant, was installed under the direction of Col. Theo. A. Bingham, Corps of Engineers, U. S. A., who represented the government. The design of the elevator system, as installed by the Marine Engine & Machine Co., is the work of Mr. Chas. R. Pratt, Mechanical Engineer of the company, and Mr. B. N. Jones, who designed the controlling system. Mr. Jones was charged with the supervision of the construction work, and he was ably assisted by Mr. C. H. Plunkett, Constructing Engineer in charge of the installation work for the company.

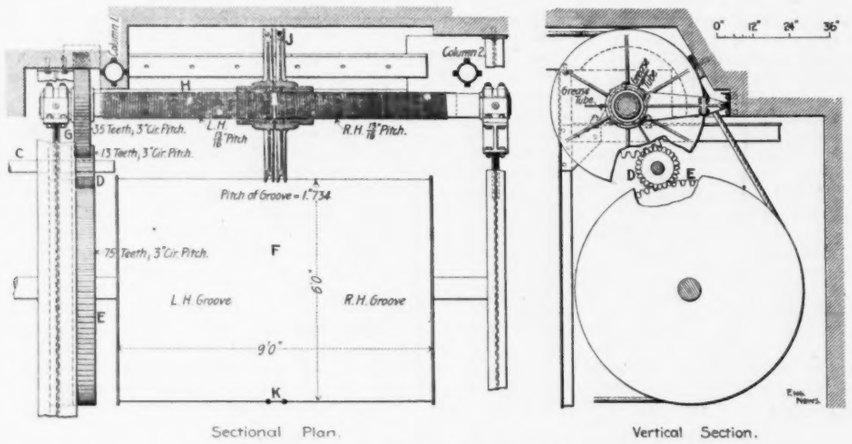

FIG. 5. WINDING DRUM OF ELEVATOR AND IDLERS.

THE UNSATISFACTORY CONDITION OF GARBAGE DISPOSAL IN THE UNITED STATES.*

By M. N. Baker.†

In no branch of the municipal service has so little progress been made in the United States as in the disposal of garbage. In no other department of municipal activity is the service so inadequate, the methods employed so haphazard, the cost so far in excess of value received. Litigation over the award of contracts and on account of alleged nuisances are common, and over the whole subject there is frequently a cloud of suspicion as to whether the various transactions are not carried on with an eye to personal and political advantage rather than in behalf of the interest of the people at large.

Why do such conditions exist? First, because the sanitary importance of a thorough system of garbage collection and disposal is appreciated by neither the general public nor the city officials; second, because it is seldom recognized that the problems incident to final disposal are largely engineering in character and therefore should be entrusted to engineers.

Although this paper is devoted to the ultimate disposal of garbage, it may be said in passing that the collection of this class of waste in a thorough and sanitary manner is a question of ample appropriations; a good equipment of covered metal carts, subjected to thorough cleansing and disinfection; suitable and well-kept horses; efficient men, and a business-like administration of the whole department. How rarely this combination is found in American cities is only too well known.

The sanitary and economic disposal of garbage is beset with difficulties and doubts. To begin with, comparatively few American cities keep trustworthy records of the quantity of garbage produced day by day. In fact, it is only where there is an efficient system of collection, either by the city or under its careful supervision, that such records are possible. Quantity records, even where regularly kept, are but rough approximations at best. Most frequently they are mere estimates, reported variously in different cities as loads, one and two-horse loads, cubic yards, or tons. Where conversions from loads to other units are made, the basis is most likely to be an estimate, the manufacturer's rating of cubical contents, or some experimental weighing of a few loads. Obviously such records are liable to gross inaccuracy. Partially full carts are often reported as full.

Meager and defective as are the records of quantities they are much more satisfactory than the available knowledge of the composition of these wastes. A few scattering analyses have been made to determine the component parts of the garbage of American cities. All else is mere guess work.

The importance of accurate figures giving the quantity and composition of garbage lies in the fact that the lack of such figures is a serious handicap in choosing between different means of disposal, in designing works, and in operating plants that have been put in service. A knowledge of the quantity of moisture to be evaporated before garbage can be burned, and of the combustible matter in the garbage, on the one hand, and, on the other, information as to the grease and fertilizing material available for possible recovery by some rendering process is essential to a wise choice between cremation and reduction. And yet in the past five years contracts involving millions of dollars have been let in complete ignorance of these facts.

Without reliable figures as to quantity and composition no city is in a position to know the unit cost of its garbage-disposal service, or to compare its results with those obtained in other cities. It is true that figures purporting to give the cost of service are put out from time to time, but except for occasional yearly totals, they are generally quite untrustworthy. Even the totals are seldom accurate, except where the work is done by contract.

All the reduction plants thus far built are owned and operated by private companies. The cities which they serve are kept in ignorance of the first cost of the plants, of the operating expenses, and of the revenue from the grease and fertilizing materials recovered from the garbage. This is all very well for the companies, but inasmuch as the latter claim as one of the advantages of their system that it is cheaper than cremation it would be well for the city if it had some means of checking these claims. It may be urged that the best possible check is competition at the time of awarding contracts. Unfortunately, genuine competition is rarely known. Adequate specifications are seldom submitted to prospective bidders. No two bids are on a strictly comparable basis. Moreover, in many instances there is no formal call for proposals. The various points at issue are settled either after a mere jaunt of some hundreds of miles to inspect existing disposal works, or else after public and private conferences with agents of rival companies. The conferences, particularly the private ones, are too apt to take place in any event.

Under such circumstances it is no wonder that the average city is quite helpless in the matter of obtaining adequate sanitary garbage-disposal service at reasonable cost. It knows little of the real quantity and composition of the material of which it wishes to be rid, neither it nor its sister cities have ever operated a reduction plant, and the conditions of awarding garbage contracts do not afford real competition between the two main rival systems—reduction and cremation—nor between the individual claimants in each class. To crown all, complicated technical questions are answered, or left unanswered, by laymen, instead of being submitted to competent engineering advisers.

While our cities have had no direct experience with the operation of reduction plants, they have had all kinds of experience with garbage furnaces. Whether or not the reduction plants operated by private companies are economic successes or failures the municipal public can only surmise; that most of the American garbage furnaces have been financially burdensome, many a city can testify from its own experience.

In England, the refuse destructors, as they are there called, not only require no extra fuel, if reports be true, but the heat from the burning wastes generates steam which is put to a variety of uses.

In the United States, instead of utilizing garbage as fuel, we use tons of good coal to consume the garbage. There have been two or three installations for which it was claimed that little or no coal was required, and one or two quite recent attempts have been made to utilize heat from garbage furnaces. These are exceptions to the general rule.

It must be understood that the English refuse is a mixture of garbage, ashes and other household wastes, and includes a large percentage of partly-burned coal and other combustible refuse. Many, probably most, of the garbage furnaces in the United States receive wastes from which at least ashes have been excluded. One of the things yet to be learned about garbage cremation in America is what results can be obtained with mixed refuse, burned in furnaces of the English type. It is generally considered by observers who are both capable and impartial that the English garbage furnaces are far in advance of the American. If so, why do not some of our cities adopt the English type? Why do not the American makers model their furnaces upon the most approved English lines? At least a partial answer to both these ques-

*A paper read before the League of American Municipalities at Jamestown, N. Y., August 21, 1901.

†Associate Editor Engineering News, New York city.

...is that in the United States engineers have rarely been called upon, either by cities or by furnace manufacturers, for advice or assistance in the designing of garbage furnaces. The case, so far as promoters are concerned, is different with reduction processes, but it would be hard to name a sanitary or mechanical engineer of national reputation who was ever prominently connected with the design of an American garbage-disposal plant of either the cremation or reduction type. No wonder that garbage disposal is in so unsatisfactory a condition!

All that has preceded relates to attempts at improved means of garbage disposal. The worst is yet to be said. The vast majority of American cities make no pretense of employing other than the most primitive methods of disposal. It is in this failure that the unsanitary condition of the garbage-disposal service, or lack of service, chiefly lies. Aside from the evils unavoidably attendant upon dumping large quantities of garbage on land or at sea there is the greater evil that where the means of disposal are unsatisfactory the collection is almost sure to be shamefully neglected.

Every town and city having a population of say 10,000 to 50,000 needs a regularly organized and efficient garbage-collection service under rigid municipal supervision, or else carried on by the muncipality itself. Each town having more than the merest makeshift of a garbage-collection service should have some other means of final disposal than promiscuous dumping. And yet in what a small percentage of the towns above even 10,000 population is the garbage collected regularly; and of these few how many fewer utilize garbage furnaces or reduction works!

I have not attempted to burden this paper with statistics, but there is now being compiled under my direction information relating to both the collection and disposal of garbage in all cities and towns of the United States having a population of 3,000 and upwards by the census of 1900. Probably a summary of this information will be available for inclusion, if desired, in the proceedings of this convention.

There remains for notice one important cause for the unsatisfactory condition of garbage disposal in the United States. It is so very important that I wish to give it the prominence of separate mention. I refer to the short-term contracts so common throughout the country. Perhaps Philadelphia is the most notorious example of the sort. Year after year, in the latter part of November or early in December, it receives bids for the collection and disposal of garbage for the ensuing calendar year. Since improved means of disposal have been adopted in that city the contract has been falling each year more and more surely into the hands of the same contractor. The period between the reception of bids and the beginning of work under the contract is too short for any one to secure a site and erect a plant. Even if there were ample time in this respect, no man without a decided political pull could take a one-year contract at a price that would not stagger any city; for without being sure of the renewal of the contract the whole first cost of the plant, as well as the cost of service, would have to be included in the bid. A five-year contract is none too long and a contract for eight to ten years, if properly safeguarded, would be more advantageous to both city and contractor. It is to be noticed, however, that at the expiration of most of the five and ten-year contracts heretofore made one or two things have occurred. Either the call for bids has been postponed until everyone but the holder of the old contract, with his plant in running order, is shut out, or else there has been a disgusting struggle between two or more factions in the city council. These struggles are frequently accompanied by lawsuits and sometimes continue for years before the matters at issue are settled. A case in point is Milwaukee. Furnaces are at last being built by the city, but not until after years of political and legal conflict.

I will now summarize a few of the points that should be borne in mind if garbage disposal conditions in the United States are to be notably improved: (1) Hundreds of cities and towns with practically no service and hundreds of others with very defective service, must establish either cremation or reduction systems. (2) The problems involved are so largely technical, and have received so little scientific attention in this country, that competent engineers should be asked to solve or assist in solving them. (3) Every opportunity should be embraced, in fact opportunities should be created, to secure more extended and reliable information regarding the amount and composition of American garbage, and the possibilities of the various means of disposal in vogue at home and abroad. The latter inquiries should be directed particularly to a determination of the relative advantages of cremation and reduction, in both their sanitary and economic aspects. Are the two processes equally sanitary and is garbage best utilized, if at all, as a fuel, or as a source of grease and fertilizing material? Such work as this might well be taken up by state boards of health, perhaps in conjunction with state boards of agriculture. (4) Contracts should be for a sufficient term of years to avoid the alternative of excessive prices on account of the necessity of quickly recovering the whole first cost, or, on the other hand, depending on political influence for a renewal of the contract. The difficulties involved might be lessened by providing for purchase by the city, or successful new bidder, at the expiration of the contract. Finally, I leave with you the question, would municipal ownership at the start be better than the contract system?

BOONE CUT-OFF AND DES MOINES RIVER VIADUCT; CHICAGO & NORTHWESTERN RY.

(With two-page plate.)

In previous issues we have described the new short line of the Chicago & Northwestern Ry., through Boone, Ia., and the great steel viaduct which carries this line over the Des Moines River.* We have recently received drawings and photographs of this structure from Mr. E. C. Carter, Chief Engineer of the Chicago & Northwestern Ry., and from these we have selected the accompanying illustrations.

BOONE CUT-OFF.—The map and profiles, Fig. 1, show an interesting comparison between the original and new locations, and are illustrative of conditions which obtain in many other cases of modern improvements upon original location and construction. The original line followed down the valley of a creek to a low level crossing of the Des Moines River, and then ascended again to the higher ground. The new line runs direct to the river, crosses it at a high level, and continues on to its junction with the original line at a point where the latter has regained its high elevation. There is nothing in this to warrant criticism of the original location, for at the time this line was projected and built the construction of the high embankments across the ravines and the long and high structure across the river was probably out of the question for financial and other reasons. It was a better policy to avoid such difficult and expensive work by a somewhat longer location to get down to the river and climb up the other side of the valley. With the growth of traffic and the increase in the train loads, and under the improved financial conditions, however, it has been a wise economy to build the new line, even at great expense, thus greatly reducing the curvature and grades, and facilitating the operation of heavy trains. A comparison of the old and new lines is given below.

	Old line.	New line.	Saving by new line.
Length	10.4 miles.	7.4 miles.	3 miles.
Maximum grades	1.5%	0.63%	.....
Minimum curvatures.	5° and 6°	2°	.....
Length of curves	5.8 miles.	0.4 miles.	5.4 miles.
Angle of curves	902° 10′	67° 52′	834° 18′
Elevation (at river)	52 ft.	210 ft.	158 ft.

DES MOINES RIVER VIADUCT.—A general elevation of the viaduct is given in Fig. 2. There are 18 towers 45 ft. long, one single-column bent, and two river piers with A columns carrying the 300-ft. deck truss span over the Des Moines River. The 45-ft. tower spans and the 21 intermediate 75-ft. spans are all of deck plate-girder construction. Fig. 3 is a general cross-section, showing the cross frames between the two pairs of plate girders. Outside of the girders are triangular bracket webs of ⅜-in. plate, which carry the sidewalks. Horizontal angle irons extend across the floor and carry the 10-in. channel standards of the side railing, these standards having outside braces, and being capped with a heavy bulb angle. At four points on each side of the structure there are refuges for hand-cars. The rails for each track are laid on separate ties, with guard timbers on the inner ends. An angle iron guard rail is placed on the inner side of each track rail, and is backed by a flat guard timber. A similar timber is placed close against the outer side of each track rail.

The foundations and method of erection were described in our issue of June 27, and the travelers are shown in the accompanying views, Figs. 4 and 7. The material, including rivets, is all of soft steel, conforming to the specifications of the railway company, and all rivets are ⅞-in. diameter, except in special cases. The assumed loading is as follows:

	75-ft. Spans.	45-ft. Spans.
Live load, per lin. ft. of track	6,100 lbs.	7,600 lbs.
Dead load, per lin. ft. of track	1,400 lbs.	1,250 lbs.

TRESTLE TOWERS.—These are of the four-leg type, 45 ft. × 19½ ft. at the top, with legs battering 1 in 6, and the general design is shown in the view, Fig. 4. Each leg is composed of two 20-in. I-beams and a 15-in. I-beam, forming a column of H section, with the web transverse to the center line of the structure. Batten plates connect the flanges at intervals. The diagonal bracing consists of pairs of 12-in. channels, set face to face, and connected by top and bottom lacing bars. These are riveted to heavy connection plates on the posts, and have square splice plates at the intersections. Four horizontal members of similar construction tie the columns together at the base of the tower, but are fitted with lattice bars instead of lacing bars. Between the tops of the columns are two pairs of transverse plate girders 20 ft. 9 ins. long and 4 ft. deep. Each pair is connected by batten plates, giving a width of 30 ins. over the outer flange angles. These girders rest on angle iron brackets on the tops of the posts.

The feet of the columns stand on cast-iron shoes 2 ft. 7 ins. square on top and 3 ft. 6 ins. square on the base, with a height of 15 ins. Two diagonally opposite shoes of each tower are fitted with expansion bearings, a ⅜-in. bronze plate, 20½ × 30½ ins., being placed between the column base and the shoe. For the fixed bearings the holes for the bolts attaching the column to the shoe are 1 17-32 ins. diameter; for the expansion bearings the holes are 2½ ins. diameter. The shoes rest on cap stones on the masonry pedestals, and are anchored at each corner by a 1¼-in. bolt 2 ft. 10 ins. long, with a split end. Through a pocket in the middle of the shoe passes a 1½-in. anchor bolt which extends down to the concrete foundation, and is fitted with a cast washer under the masonry.

STEEL PIERS FOR RIVER SPAN.—The 300-ft. deck truss span over the Des Moines River is carried by a rather novel system of supports. Each end rests upon a steel pier or tower, consisting of a pair of triangular bents or A frames connected by transverse bracing, as shown in Fig. 4. Some of the details of construction are shown in Fig. 5. Each bent has a width of 27 ft. 3 ins., c. to c. of posts at the base; while the center lines meet at a point 2 ft. above the cap plate, the total height from base to cap plate being 81 ft. 1½ ins. The sides batter 1 in 6. The posts are of box section, with four angles and three plates, the fourth side having two narrow plates with lacing bars across them. The section is stiffened by internal horizontal diaphragm plates riveted to angle iron brackets on the side plates. The diagonal members are pairs of 12-in. channels, set face to face and connected by lacing bars. At the base of each tower the posts are connected by four horizontal members, each composed of a pair of 15-in. channels, with top and bottom lacing bars and batten plates. The top of each bent is finished off with two side or web plates ½-in. thick and 16 ft. 1⅝ ins. deep, cut to fit the slope of the posts. These are stiffened by a vertical diaphragm between them, composed of a ⅝-in. plate and four flange angles. The two bents are connected at the top by two transverse simple trusses 8 ft. deep, with top and bottom chords of single 12-in. channels and diagonal members of angles ½ × 4 × 6 ins. The bottom chords are connected by horizontal diagonal bracing. The character of the construction of these trusses is shown in Fig. 5.

PLATE GIRDER SPANS.—The plate girders for the 45-ft. tower spans and the 75-ft. intermediate spans are all 7 ft. deep, with double flanged top chords, having reinforcing plates fitted between the flanges for a length of 39 ft. 11 ins. at the middle of the span, as shown by the detailed section in Fig. 6. The bottom chords are composed of flange angles ⅝ × 8 × 8 ins. A peculiar feature of the construction is that the girders are halved together at their ends. The lower portion of the 45-ft. girders on the tower project about 13 ins. beyond the upper portion, and carry steel castings which receive the forged steel bearings on the projecting upper portion of the 75-ft. girders. This construction is shown in Fig. 6.

TRUSS SPAN.—The general design of the 300-ft. deck truss span crossing the Des Moines River is shown in Fig. 2. The trusses have parallel

*Engineering News, Feb. 8, 1900; June 6, 1901; June 27, 1901.

chords, are divided into five main panels, and are 60 ft. deep, c. to c. of chords. They are pin-connected throughout, the end pins being 10 ins. diameter. The top chord has two side plates 30¼ ins. deep and 22 ins. apart, with outside flanges only, connected by top and bottom lacing bars and batten plates. The bottom chord in each end panel is of similar construction, but 24¼ ins. deep and with sides 33½ ins. apart. The end posts have three double flanged webs, and are 30¼ ins. wide and 29 ins. apart. The three center panels have the bottom chords composed of eyebars, the intermediate verticals carrying the transverse bottom struts. The longitudinal struts between intersection points are pairs of 12-in. channels, with top and bottom lacing bars.

In order to reduce the height of the steel piers, the floor beams are placed on top of the upper chords and upon these again are the track stringers. The provision for expansion and contraction consists in making the end posts of one end as a rocker bent, with slotted holes for the pins in the bottom chord and longitudinal strut.

ENGINEERS AND CONTRACTORS.—The viaduct was designed under the direction of Mr. E. C. Carter, M. Am. Soc. C. E., Chief Engineer of the Chicago & Northwestern Ry., and Mr. W. H. Finley, Principal Assistant Engineer (then Engineer of Bridges). Mr. Geo. S. Morison, M. Am. Soc. C. E., was Consulting Engineer. The construction of the entire cut-off, including the erection of the viaduct, was under the supervision of Mr. W. C. Armstrong, Resident Engineer for the railway company. The viaduct was built by the American Bridge Co., Mr. T. W. Cartledge being superintendent of erection for that company. Winston Bros., of Minneapolis, Minn., were the general contractors for the Boone County Ry., exclusive of the viaduct. The Engineering Contract Co. had the contract for sinking the cylinder piers, and G. Widell, Mankato, Minn., was the contractor for the rest of the masonry work, pedestals and abutments.

ORE DOCKS WITH METAL PILING.

One of the ore docks of the Cleveland, Lorain & Wheeling Ry., at Lorain, O., is of interest in that metal piles are used in its construction; the piles for part of the dock being of wrought-iron pipe, while for the rest of the length they are of steel I-beams. The construction is shown in the accompanying cuts made from blue prints furnished by Mr. W. B. Hanlon, Chief Engineer of the C., L. & W. Ry. The work was done by the railway company, under the supervision of Mr. Hanlon.

The dock is equipped with Brown hoisting devices for unloading the ore, a considerable part of which is stored on the dock, so that the wall has to withstand a considerable thrust, while the passage of switching engines subjects it to vibration. The shale rock at the front of the dock is about 18 ft. below the water line, and in rebuilding and extending the dock in 1899 it was decided to use piles made of 8-in. wrought-iron gas pipe, or what is known as drive pipe. This construction is shown in Fig. 1. The piles are 36 ft. long, and are let 10 to 14 ft. into the shale rock, holes 10 ins. diameter being drilled for a platform. The piles are 8 ft. apart c. to c., and carry inside and outside lines of waling timbers, while behind the inner wales is a row of 6-in. sheet piling, 24 to 26 ft. long. Below the timber wales are two lines of rails to guide the sheet piles in driving, and to resist the pressure of the material behind the foot of the sheet piling. The upper line is supported by suspension rods, as shown, while the lower row rests upon the mud of the lake bottom. Behind this dock wall are the timber piles for the track of the ore hoists and conveyors. There are two rows of timber anchor piles, 23 ft. apart, the piles in each row being 8 ft. c. to c. From the waling timber on the shore side of the inner row of piles extend three sets of horizontal anchor rods, all spaced 8 ft. c. to c. One set of 1¼-in. rods extends to the stringer along the top of the outer timber piles; another set of 1¼-in. rods extends through to the outer waling timber of the iron piles; while the third set of rods, 1-in. diameter, are attached to collars on the iron piles. These latter were used temporarily to hold the iron piles in place while the waling timbers and sheet piling were being placed.

The iron piles were coated with Egyptian asphalt while hot, and cost (delivered at the dock) 84 cts. per ft. This cost included a 3-ft. section of 7-in. pipe which was inserted in the 8-in. pipe when the concrete filling came within 18 ins. of the coupling joining the two sections of 8-in. pipe. This 7-in. piece was placed there to strengthen the joint. The work of drilling the holes and placing the pipe was done by contract at $24.75 per hole, and the concrete filling was placed by the company's forces. The backfilling is of slag, filled in behind the sheet piling to the level of the floor of the dock. The total cost of the dock construction on this plan was about $30 per lin. ft., including backfilling, while a timber crib dock built near it by the U. S. government engineers cost $50 per lin. ft. This part of the iron dock front is 640 ft. long, and has been in use since September, 1899. As it is on the river front, near the mouth of the river, it has received very hard service from the largest lake vessels in time of storms, but is nevertheless in very good line and condition.

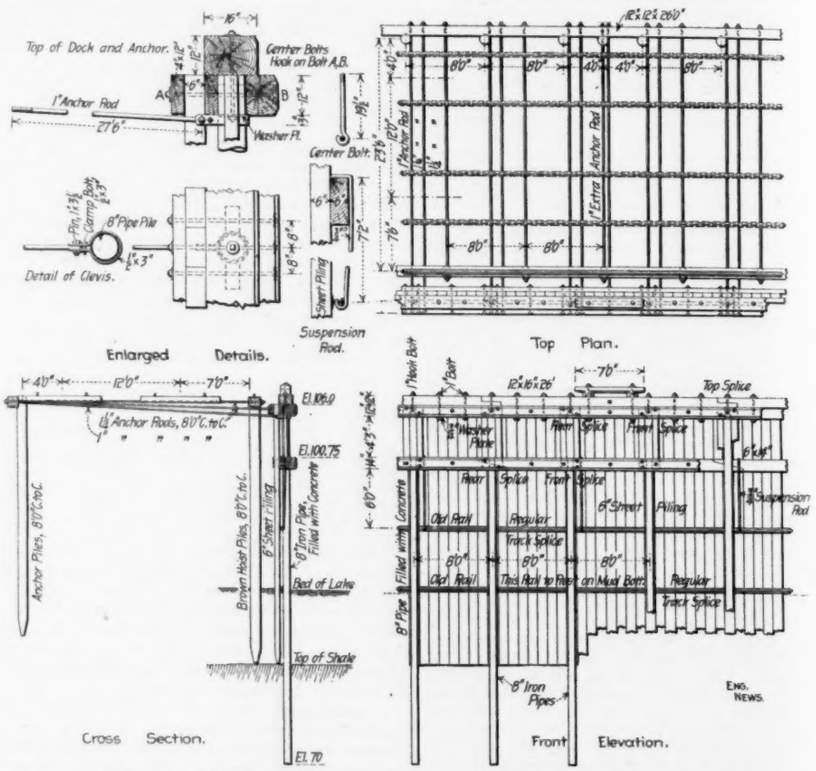

FIG. 1. WALL OF ORE DOCK WITH PILES OF 8-IN. IRON PIPE; CLEVELAND, LORAIN & WHEELING RY.
W. B. Hanlon, Chief Engineer, Cleveland, O.

In 1900, when the dock was extended for a length of 540 ft., it was decided to use 10-in. 40-lb. I-beams for the front piling, and these are set in 13-in. holes drilled in the shale, to a depth of 10 or 12 ft. This construction is shown in Fig. 2. The piles are 8 ft. c. to c., and at the top they are sandwiched between white oak timbers 7 ft. long, notched for the double lines of waling timbers. About 6 ft. below the lower wales is a line of old 56-lb. rails, suspended by ¾-in. rods, and serving to hold the sheet piling in line. These rails are in lengths of about 17 ft., with the ends overlapping. The wall is anchored back to the timber piles by 1¼-in. rods.

When the piles were set, the 13-in. holes were filled with concrete by the company's men. The cost of drilling the holes and setting the piles were $30 per pile. This part of the dock is not yet finished, but the cost of the dock completé, including the backfilling behind the sheet piling, will be about $30 per lin. ft. This form of construction is considered preferable to that in which the pipe piles are used.

THE ECONOMIC VALUE OF THE CLARION COAL IN VINTON AND JACKSON COUNTIES, OHIO.*

By N. W. Lord.†

The work described in this paper was done in connection with the Ohio Geological Survey, and with the co-operation of Prof. Edward Orton, Jr., the State Geologist. It is planned to continue the investigation of the less-known Ohio coal seams, so that their economic value may be tested and published.

The Clarion coal of Pennsylvania, or rather the two seams, the Upper and the Lower Clarion, sometimes called the scrub-grass and Clarion seams, extend pretty near through the area of the coal measures of Ohio, but throughout the greater part of the state the seams have but little economic value, and, excepting possibly in some parts of Mahoning county, are not of much importance in the Northern and Eastern parts of the field. However, in Jackson and Vinton counties the seam developes into one of considerable thickness, and covers a large portion of the coal area of these two counties, where it is known locally as the Limestone coal, and sometimes as Coal No. 4, or 4 A. It is opened in a number of places, mostly in local country banks or railroad mines.

The samples on which our present work is based were taken by Professor Orton last summer during a trip through the field. They were secured at points distributed carefully over the field so as include the whole area known to contain the seam in considerable thickness.

Of the samples all but 3, 4 and 7 are from railway mines. No. 7 is a country coal bank supplying wagon trade, and Nos. 3 and 4 are openings. 50 to 75 ft. under the hill. All afforded good sections of the coal. The samples were taken by "channeling" the vein from the roof to the floor, rejecting partings only. They were broken up, mixed, and quartered, and sent to the laboratory in sacks. Each sample weighed from 100 to 150 lbs.

The accompanying table gives the results of

*Abstract of a paper read before the Ohio Institute of Mining Engineers at the February meeting, 1901.
†Ohio State University, Columbus, O.

the work done on these samples in the metallurgical laboratory of the Ohio State University. I wish to acknowledge the assistance I received from Mr. E. E. Somermier, instructor in metallurgy, who carried out the details of this analytical and calorimetric work.

The proximate analyses were made by the method used in the former work of the Ohio Geological Survey, and published in Vol. 5, Ohio Geological Survey Reports. The ultimate analyses were made by the ordinary combustion method. The ash is that left after burning, and is not corrected for oxygen replacing sulphur. The oxygen is determined by difference, using the ash thus determined. The nitrogen was determined by the Kjeldahl process and sulphur by the Eschka method. The calorimeter determinations were made in the Mahler bomb and the results corrected for the sulphur burned to sulphuric acid, deducting twelve calories for each 1% of sulphur present. This figure represents the error due to calling the acidity in the bomb liquor nitric acid when it is largely sulphuric acid, it leaves the heat due to the combustion of the sulphur to SO_2 intact. The reason why the ash in the ultimate analysis was not corrected for sulphur was the uncertainty as to the mode of combination of the sulphur, as will appear in the sequel. The tables show this coal to be high in sulphur, but of satisfactory character as to moisture and ash. The sulphur is noticeably irregular in the seam, varying from 2.87% to 6.14%. The analyses, of course, represent "run of mine" and not selected coal.

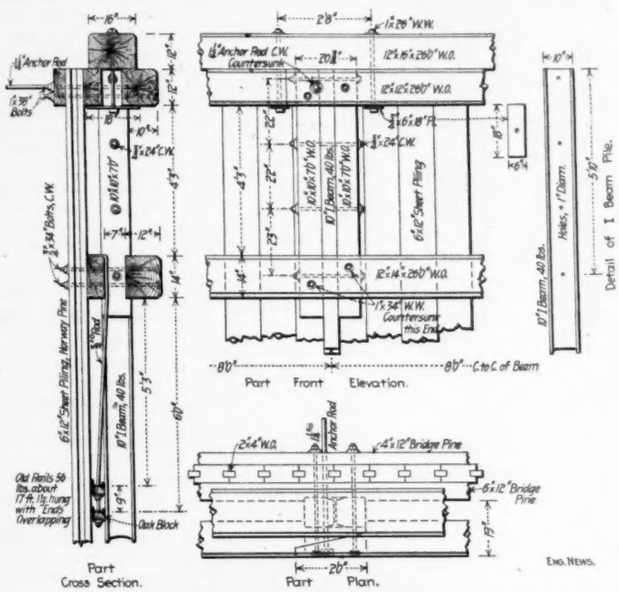

FIG. 2. WALL OF ORE DOCK WITH PILES OF 10-IN. I-BEAMS; CLEVELAND, LORAIN & WHEELING RY.

Laboratory tests showed very little coking power in the coal.

Considering the ultimate analyses, the variations in the carbon, hydrogen and oxygen correspond closely to the variations in the amount of inert material. So that, taking the individual analyses, they show this fact, which has been frequently established in other coal veins of the state, viz.: that the ultimate composition of a coal seam (that is, its hydrogen, carbon, sulphur, nitrogen and oxygen) remains practically constant over considerable areas of the field. So, if we regard the seam as a mixture of coal, pyrites and ash, the coal part of the mixture is practically the same thing throughout a large area of the field. It is, therefore, possible to examine the coal part separately and determine its value as a heating material, and discuss separately the admixed impurities. The heating value corresponds very closely to that calculated by Dulong's formula from the ultimate analyses.

Dulong's formula as used = 8,080 C + 34,460 (H − ⅛ O) + 2,250 S.

The average heating value of the combustible is 8,187 = H.

$$\left\{ H = \frac{\text{Average calorimeter} - \text{average S} \times 2.250}{1 - (\text{ave. ash} + \text{ave. S} + \text{ave. moisture.})} \right\}.$$

This is compared in the following table, with the corresponding value of H, for other well-known coals:

	Coal.			
	Pittsburg.	Hocking.	Wellston.	Clarion.
Average heat power....	7,532	6,663	6,953	6,694
Value of "H".....	8,435	7,925	7,929	8,187
Calculated evaporation.*	9.8	8.6	9.3	8.9

*In pounds.

The heating value of the individual samples calculated from this average value of the combustible, show a satisfactory correspondence, confirming the writer's previous experience that the character of the coal as shown by its heating power is practically the same over considerable areas of a given seam. Nos. 10 and 18, which depart most widely from the rule, are both in outlying parts of the field. No. 10 on the extreme west, and No. 18 on the south.

To investigate the mode of occurrence of the sulphur in the coal samples Nos. 1 and 10 were taken as representing the highest and lowest percentages. In each of these samples the iron and the ash were carefully determined. This iron was then calculated as existing in the coal as pyrites and the sulphur necessary for this combination estimated as present in this form. In No. 1, the percentage of iron in the ash was 13.4%; iron in the coal, 1.03%; sulphur combined with iron in the coal as pyrites, 1.18%. Subtracting this from the total sulphur, 2.87%, we find in that coal 1.69% of sulphur not as pyrites.

In sample No. 10, containing 6.14% sulphur, the iron in the ash amounted to 30.10%; iron in the coal, 4.12%; sulphur as pyrites, 4.71%; sulphur not combined with iron, 1.43%; showing a residual of sulphur in this case only a little less than in the other. In other words, the variation in sulphur is due to the pyrites and not to variation of the organic sulphur in the coal, this figure being practically the same in the two cases.

In order to test this a little further, sample No. 3, containing 3.70% sulphur, and No. 10, containing 6.14% sulphur, were crushed until they would go through a half-inch mesh and then washed. We washed it by hand in a miner's pan. We have found by numerous experiments that coal-washing by hand can be conducted so as fairly to represent that done on a large scale. We found in No. 3 sulphur in the washed coal, 3.08%; ash, 6.40%; moisture, 3.85%. In No. 10, we found sulphur in the washed coal, 3.72%; ash, 8.70%; moisture, 4.00%. In other words, the sulphur brought down by washing was very small in No. 2, but large in No. 10, where there was a large per cent. of sulphur as pyrites, the reduction being in this case nearly 50%.

These experiments show that of the sulphur about 1.5 or 1.6% is "organic sulphur," the rest being in the form of pyrites, and varying locally in the coal, that washing might be expected to reduce the total sulphur to a uniform figure in the neighborhood of 3%. The steam-raising power, or the relative evaporating power, may be calculated by the formula published by the writer in the Engineering News of Feb. 16, 1899. I have given this value in the foregoing tables for comparison with its value for the other coals.

Summing up the results of our tests, I may say the Clarion coal in Vinton and Jackson counties has a steam-raising value intermediate between Hocking and Wellston coal; that it is locally highly contaminated with iron pyrites, but areas exist in which the pyrites is not very large in amount, but the total sulphur of the coal, of which possibly one-half would be organic sulphur, and therefore not represented by iron, will in few cases go much below three per cent., but with careful selection should be mined between three and four, with pyrites contents equivalent to one and a-half to two and a-quarter per cent. of sulphur. The amount of pyrites should not, therefore, be large enough in carefully-selected coal to be seriously detrimental in a steam fuel.

THE PRODUCTION OF RAILS FOR 1900 in the United States amounted to 2,385,682 tons, according to statistics recently made public by the American Iron and Steel Association. Of this tonnage 2,383,654 tons were Bessemer steel rails, 1,333 tons were open-hearth steel rails and 695 tons were iron rails. The following table gives the total production of rails in the United States in 1900 according to the weight of the rails per yard. Included in the total production are 101,312 tons which have been definitely reported to the association as street rails:

Kinds.	Under 45 lbs.	45 lbs. and less than 85.	85 lbs. and over.	Total, gross tons.
Bessemer	155,950	1,625,646	602,058	2,383,654
Open hearth ..	886	447	.....	1,333
Iron	695	.....	.....	695
Total	157,531	1,626,093	602,058	2,385,682

TRACK ELEVATION AT CINCINNATI, O., is proposed by the Pennsylvania Lines, and it is expected that the Baltimore & Ohio Southwestern Ry. will undertake a similar work. The proposition made to the city by Mr. Ralph Peters, General Superintendent of the Pennsylvania Lines, includes the removal of all crossings between Red Bank and Parsons St., the cost to be divided as follows: Where only the city and railway are involved, 35% to be paid by the former, and 65% by the latter; where the street railway company is also involved, that company to pay 25% and the Pennsylvania Lines 40%. It is proposed that this should be undertaken as a street improvement, the credit of the city being used to provide the necessary funds by a bond issue covering a term of 10 years. The entire cost is estimated at $630,000, divided as follows: Pennsylvania Lines, $343,550; city of Cincinnati, $211,450; Cincinnati Traction Co., $75,000. This proposition was made to the Mayor, and referred by him to the Board of Legislation. He thinks that while the law provides that railways must pay not less than 65% of the cost of eliminating grade crossings, the proportion paid for the proposed work in Cincinnati should be higher, and he has suggested that the board make an investigation as to the proportions paid by the railways for similar work in other cities. The matter of abolishing grade crossings was taken up last spring by the Board of Legislation, and Mr. Edward Breen, Assistant City Engineer, was appointed Superintendent of Track Elevation and Subways, as noted in our issue of July 11. A committee visited Chicago, Buffalo and other cities, where the grade-crossing problem has been taken up in earnest, and a report on its investigations has been made.

Table Showing the Results of Calorimeter Tests of Clarion Coal in Jackson and Vinton Countries, Ohio.

Sample No.	Location of mine.	Carbon.	Hydrogen.	Oxygen.	Nitrogen	Sulphur	Ash.	Moisture.	Vol. combustible.	Calorimeter	Fix'd carbon.	Calculated—From results	Calculated—From mate	Calorific power calculated—From "H."
1.	Sec. No. 34, Vinton township, Vinton Co., O..	68.52	5.49	13.69	1.28	2.87	8.15	5.02	40.31	46.51	6,927	6,903	6,947	
2.	" " 35, Milton township, Jackson Co., O.	67.30	5.47	14.16	1.28	3.70	8.09	5.61	38.92	47.38	6,821	6,794	6,854	
3.	" " 13, " " "	66.14	5.39	13.31	1.28	4.08	9.80	4.98	39.71	45.51	6,752	6,720	6,743	
4.	" " 36, " " "	67.51	5.44	13.45	1.26	3.73	8.61	4.71	40.51	46.17	6,867	6,834	6,883	
5.	" " 33, Vinton township, Vinton Co., O.	64.91	5.36	12.05	1.30	5.28	11.10	4.61	41.35	42.94	6,696	6,694	6,594	
6.	" " 24, Wilkesville township, Vinton Co.	65.04	5.36	12.95	1.28	4.16	11.21	4.72	39.88	44.19	6,694	6,637	6,684	
7.	Wellston, Jackson county, O.....	66.52	5.50	14.58	1.28	3.72	8.40	5.33	41.01	45.26	6,781	6,726	6,850	
8.	Minerton, Vinton county, O.	67.17	5.44	13.03	1.28	4.23	8.85	4.52	40.10	46.53	6,854	6,834	6,849	
9.	Sec. No. 32, Bloomfield township, Jackson Co.	62.05	4.98	12.12	1.23	6.08	13.54	5.31	37.33	43.82	6,321	6,346	6,291	
10.	" " 32, Madison township, Jackson Co..	62.57	4.89	11.47	1.23	6.14	13.70	4.90	35.75	45.65	6,386	6,386	6,307	
18.	" " 5, Bloom township, Scioto Co., O...	65.30	5.33	15.35	1.23	3.45	9.34	6.80	37.92	45.94	6,535	6,528	6,669	
	Average	65.73	5.33	13.29	1.27	4.31	10.07	5.14	39.85	45.45	6,694	6,673	6,694	

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A subject of much importance to water-works men is the proper basis of charge for private fire service to mill property and other large buildings. Informal discussions on this topic were held at two meetings of the New England Water-Works Association last winter. Advance copies of these discussions have been printed for general distribution with a view, as we understand it, of eliciting still further opinions at the fall meeting of the association. That meeting will be held in September. The matter is in charge of a committee, of which Mr. Byron I. Cook, of Woonsocket, R. I., is chairman. On the one hand, the mill-owners and insurance interests hold that this service should no more be a direct charge on the protected risks than are street hydrants. On the other hand, the water-works men claim that there are differences between the two classes of service, and that one of the chief of these is the surreptitious use of water for other than fire protection purposes. If the stealing of water is feared nothing short of a water meter is an adequate safeguard. The fire insurance people object to meters on mill services used for fire protection. Other arguments may be found in the pamphlet already mentioned, copies of which may be had by applying to Mr. C. W. Sherman, 1 Ashburton Place, Boston, Mass.

In view of the recent discussion and litigation over garbage disposal in Greater New York, some statements from the report of the department of street cleaning for the year 1900 are of particular interest. The first of these to be noticed is a reference to the fact that the contract for garbage collection and disposal in the borough of Brooklyn expires on Jan. 1, 1902. Although that date is only four months distant, and the department has just been severely criticised for delaying to advertise the contract for Manhattan and the Bronx until the time was so short as to render competition impossible; bids for handling the Brooklyn garbage after Jan. 1 have not yet been invited. If bids were to be received to-day the time for the erection of a new plant would be altogether inadequate. We venture the suggestion that if a long-term contract for Brooklyn be awarded it should expire on Aug. 1, 1906, at the same time as the contracts for Manhattan and the Bronx. By keeping the same plan in view for Queens and Richmond boroughs the garbage disposal for the entire city could be considered as a whole after Aug. 1, 1906.

The next thing to be noticed is the fact that the amount of garbage collected in Manhattan and the Bronx during the last four calendar years does not bear out the recent attempted justification for an increase of 150 per cent. in the yearly price under the new contract. The figures show that more garbage was collected in 1897 than in any year since then. The actual quantities in tons, as given in the report, are as follows: 1897, 154,000; 1898, 139,000; 1899, 151,600; 1900, 146,600. True, the report states that this indicates a lack of proper separation of the garbage. But what guarantee is there that the separation will be improved in the future? The report strongly asserts that no effective aid to this end could be secured by either the police or health departments. This is by no means the worst of the department's own story. In September, 1900, the New York Sanitary Utilization Co. complained that through faulty separation it was not getting all the garbage to which it was entitled, and that the scow-trimming contractor was reaping a rich harvest from the bones and grease improperly mixed with the ashes and street sweepings. The department, with apparent satisfaction to both the garbage and scow-trimming contractor, effected a compromise under which the city paid the latter 60 cts. a barrel for bones and 1¾ cts. a pound for grease, "which were turned over to the Sanitary Co." Under this happy arrangement the stuff culled out increased week by week until for the last week in December the city actually paid the scow-trimmer $2,127 on this account. In other words, the city was paying one contractor at the rate of $113,000 a year for grease and bones to be turned over to another contractor who was receiving $89,990 a year for towing all the garbage from the city dumps to Barren Island and there treating it by the reduction process.

Finally, in order that it may not be supposed that all these difficulties would disappear by the mere substitution of cremation for reduction, an experience with a garbage furnace may be cited. A furnace on Staten Island was erected in November, 1899, and bought by the city in February, 1900. It was supposed to have a capacity of 30 tons a day, but, the report states:

> It was only with great difficulty that it consumed a daily winter output of ten tons within that time. As summer came on the garbage output began steadily to increase, and by the first of June it had reached such proportions that the crematory collapsed in its struggle to dispose of it. The only other disposition possible for the garbage now was to deliver it to the New York Sanitary Utilization Co. for transportation to Barren Island. This was done at an increase in expense of about $1 per ton. This method of disposal continued through the summer and until Nov. 1, when the collections had decreased to an extent that they could be consumed by the crematory, which had in the meantime been overhauled and put in working order. Since that time the crematory has disposed of the greatly-reduced output, but at any time it may break down again.

A surprising announcement relating to the flow of water in pipes is included in a paper of nearly two hundred pages, to be presented to the American Society of Civil Engineers at its first meeting of the season, on Sept. 4. The paper in question is the joint work of Messrs. Gardner S. Williams, M. Am. Soc. C. E.; Clarence W. Hubbell, Assoc. M. Am. Soc. C. E.; and Geo. H. Fenkell, Jun. Am. Soc. C. E. It is founded on observations begun by the authors as far back as 1893, and continued from time to time until the early part of 1901. The announcement to which we desire to call attention is Final Conclusion K of the paper. It reads as follows:

> The discovery and demonstration that curves of short radius, down to a limit of about 2½ diameters, offer less resistance to the flow of water than do those of longer radius, and hence the theories and practices regarding curve resistance, as set forth in the hydraulic treatises of all nations up to the present time, are absolutely incorrect and the diametric opposite of the true conditions.

We will not attempt to forestall the discussion to which this conclusion seems likely to give rise, but take this opportunity to remind the members of the society, and to apprise others interested, that the paper will be read in two weeks. We would also say that neither the interest nor the value of the paper depends upon this single conclusion, and the observations upon which it is based. The studies as a whole developed many interesting things, both in the way of apparatus for gaging the flow, and in contributions to the theory and practice of the flow of water in pipes. Particular mention may be made of a new oil differential gage for observing differences in head in pressure conduits "with as great a degree of precision as is attainable in open conduits with the hook gage;" also "the invention of a form of Pitot tube which may be inserted in a water main without the aid of special devices."

ROUNDHOUSE CONSTRUCTION AND EQUIPMENT.

Within recent years extensive and important improvements have been made in the design and construction of locomotives, and in the design and equipment of machine shops for carrying out general repairs to the locomotives. Improved methods of operation have also been introduced, in order to get more work out of the engines, or to work them more nearly to their full capacity. There has, however, been much less progress in the improvement of roundhouses, and their facilities for housing and cleaning the locomotive and making such running repairs as are required by engines in service. On many roads having modern locomotives and modern shops, there yet exist roundhouses of insufficient size, with defective lighting and ventilation, and with primitive and uneconomical facilities for cleaning the engines and making running repairs. Some of these roads are effecting temporary improvements to meet pressing conditions, but in general the matter needs to be treated in a more comprehensive and radical manner than has hitherto been done. The above remarks as to roundhouse facilities apply equally to the means of supplying water, coal and sand, and the facilities for handling the coal and ashes, as all of these matters bear an important relation to the service performance of the engine.

These conditions, as above outlined, are well understood by the officials of the motive power departments, and have recently been made the subject of investigation by committees of the Railway Master Mechanics' Association and the Central Railway Club. The reports of these committees, and the discussions which followed their presentation, have suggested a number of points which we have here taken up for consideration.

Roundhouse work is almost always done under pressure, the transportation department often begrudging the time that the engines remain in the house. This department sometimes calls for an engine almost as soon as it has been put in the house, before there has been a chance to do even such work upon it as is absolutely necessary. When an engine is sent to the roundhouse, it has to be at least cleaned, and have all its working parts inspected, overhauled and lubricated; perhaps the boiler has to be washed out, lamps cleaned, and some light repairs made, valves set, driving-boxes tightened, etc. In many cases the fire has to be cleaned or dropped, and the engine supplied with coal, water and sand; all this (with the exception of filling the sandbox) being done outside the house. Finally, the fire has to be lighted to put the engine under steam ready to leave the house for another trip. As it is important to keep the engine in service as much as possible, and also to keep it in as good condition as possible, it will be seen that the roundhouse facilities cannot be neglected without detracting from the economical performance of the locomotives. In a number of instances, the roundhouses have not enough tracks or stalls to accommodate all the engines, or are not wide enough to receive the long modern engines with their tenders. In

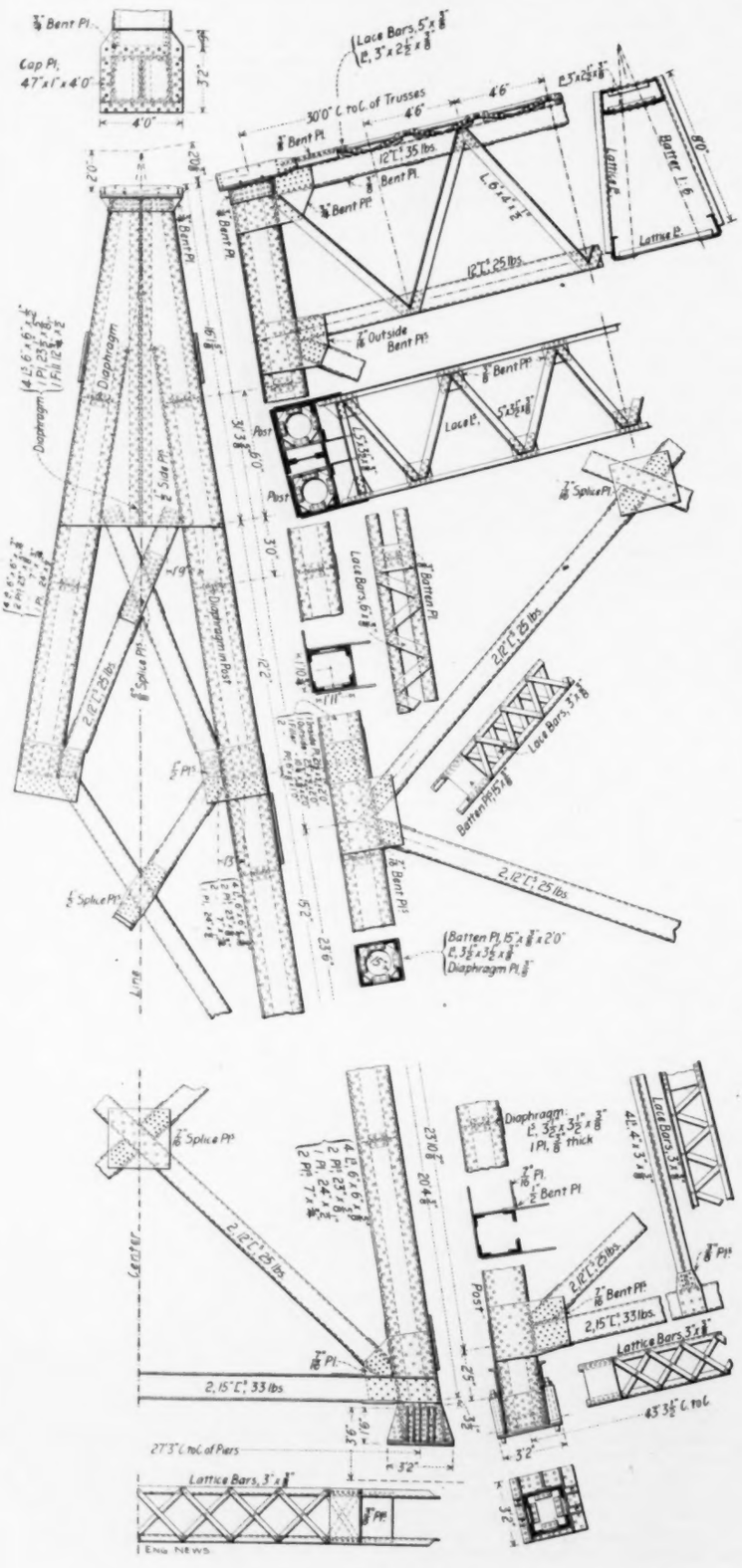


FIG. 5.

STEEL TOWER FOR 300-FT. SPAN.

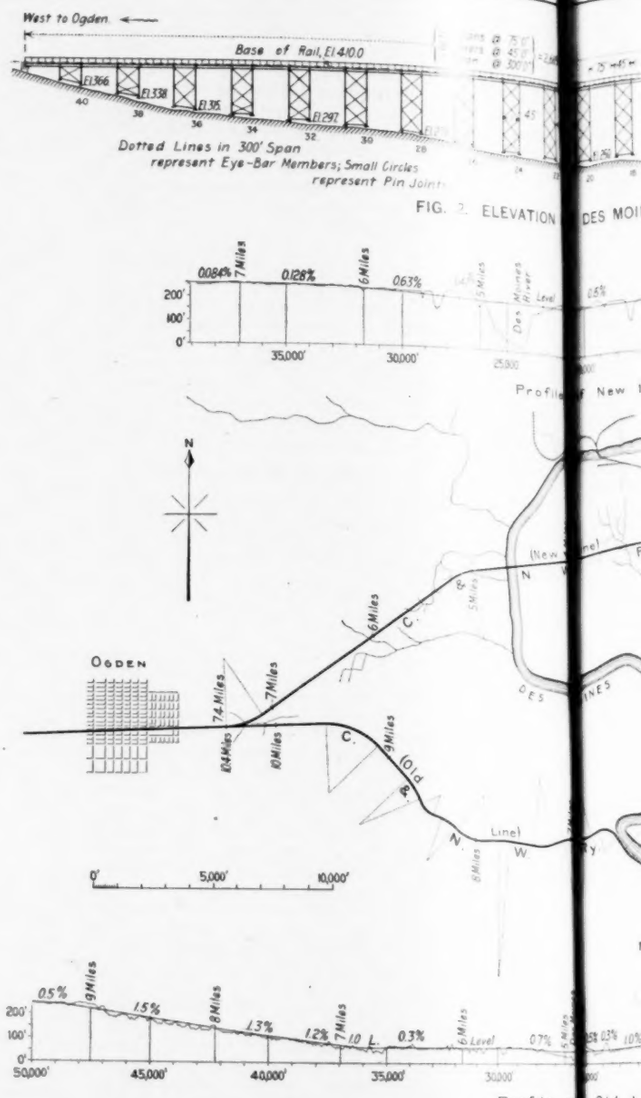


FIG. 1. MAP AND PROFILE OF OLD AND NEW LINES OF BOONE TO OGDEN.

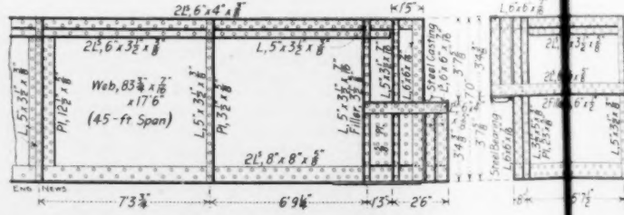
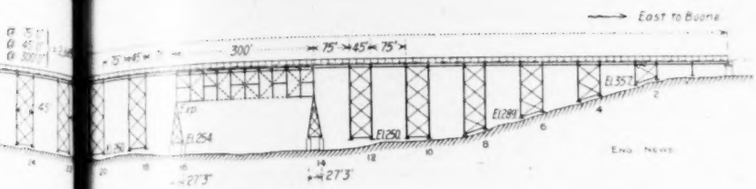


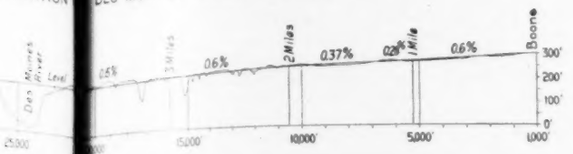
FIG. 6. PLATE GIRDER SPA

BOONE CUT-OFF AND DES MOINES
CHICAGO & NORTHWESTE

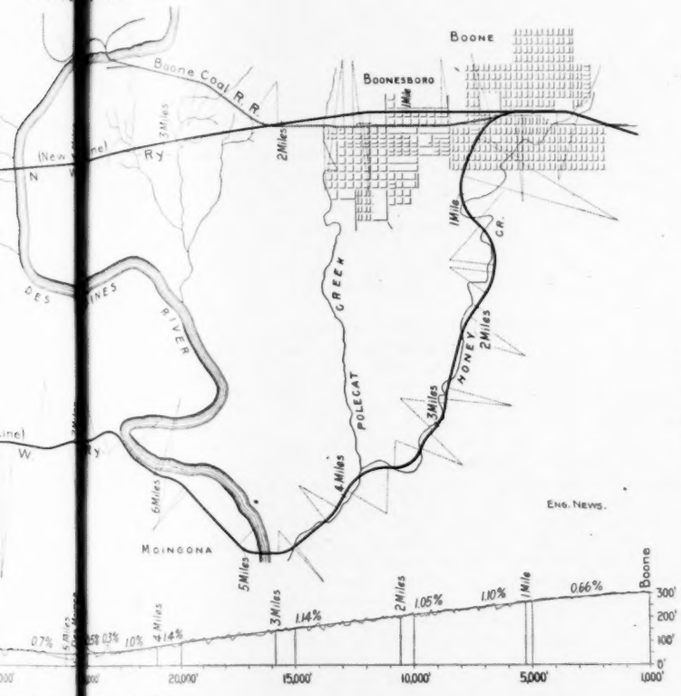
E. C. Carter, M. Am. Soc. C. E., Chie
Geo. S. Morison, M. Am. Soc. C. E., Co



ELEVATION DES MOINES RIVER VIADUCT.



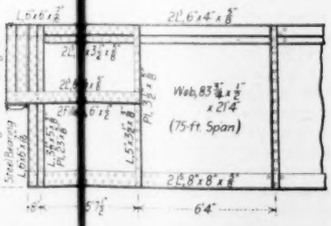
Profile of New Line.

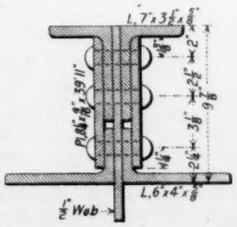


Profile of Old Line.

AND NEW LINES OF THE CHICAGO & NORTHWESTERN RY.;

BOONE TO OGDEN, IA.





Top Chord Section, Enlarged.

PLATE GIRDER SPANS.

ID DES MOINES RIVER VIADUCT,
& NORTHWESTERN RY.

Soc. C. E., Chief Engineer.
m. Soc. C. E., Consulting Engineer.

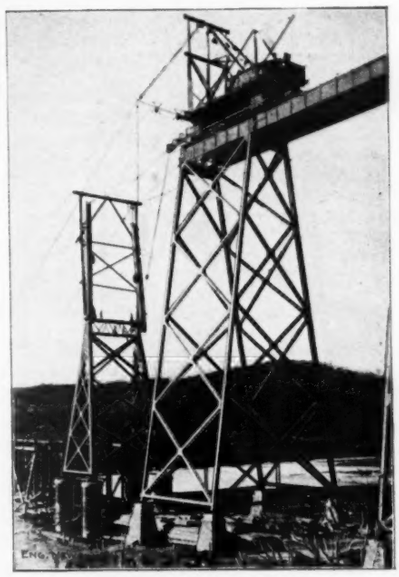


FIG. 4. TRESTLE TOWER AND STEEL PIER (TRAVELER SETTING END POST OF 300-FT. SPAN).

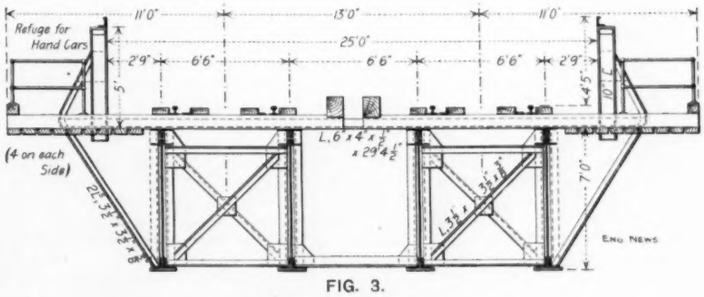


FIG. 3.
CROSS-SECTION OF VIADUCT.

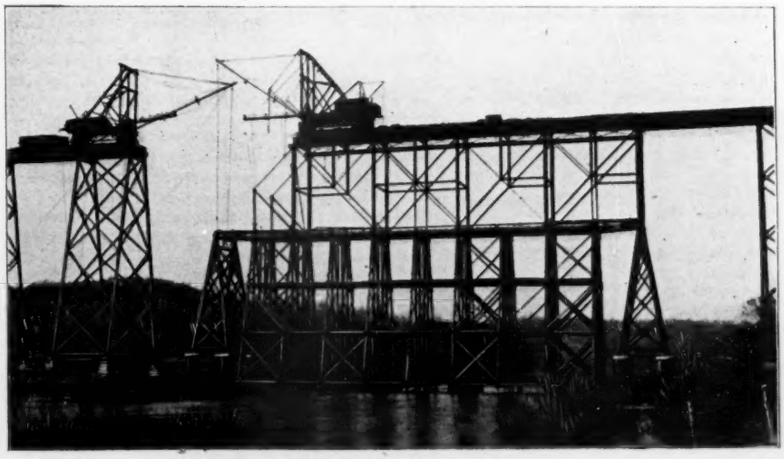


FIG. 7. TRAVELERS ERECTING 300-FT. SPAN ON ITS FALSEWORK.

the former case the engines must stand on the side tracks, and in the latter case the doors cannot be shut behind these engines. Both cases represent a source of discomfort and trouble in the winter, and do not conduce to the proper maintenance of the engines. In some cases this difficulty has been obviated by the temporary expedient of building an extension or vestibule for some or all of the tracks. This is generally built on the outer side of the house, the wall being replaced by columns supporting the roof, but in some cases the house is on the inner side, or towards the turntable.

A space of 10 ft. between the engine and each wall is recommended as good practice, in order to give room for handling the machinery in repairs, and as some engines are 70 ft. long over all, the width of roundhouse for such engines would be 90 ft. The roundhouse of the Chicago & Northwestern Ry., at Clinton, Ia. (Eng. News, Feb. 14, 1901), is 81 ft. 6 ins. wide inside, with radii of 187 ft. 6 ins. and 106 ft., the longest engines on the division being 62 ft. 8½ ins. over all. The report read at the annual convention of the American Railway Master Mechanics' Association (Eng. News, June 27, 1901), recommended a width of not less than 80 ft. It is advisable to avoid the use of intermediate posts within the roundhouse, and this has been effected in some cases by the use of steel roof trusses, spacing the entire width of the building. In this connection mention may be made of some French roundhouses which are of dome shape, with steel arched ribs or trusses. To protect the trusses from the corrosive effects of smoke and gases a concrete and metal ceiling should be placed between the lower chords. We might also suggest the economizing of space by the erection of a storeroom over the roundhouse.

The most approved floor construction consists of vitrified brick paving, laid on edge and grouted with tar. In the most substantial construction, the bricks are laid on a concrete foundation, but they may be laid simply on a bed of sand, or on a bed of slag or gravel 6 to 12 ins. thick, well-tamped or rolled, and grouted with hot tar. Wooden floors soon rot out and wear out under the conditions of roundhouse service, and concrete floors are liable to become cracked and disintegrated on the surface. Swinging wooden doors are usually employed, but some modern roundhouses have steel rolling doors, and these latter may be necessary where a vestibule (for long engines) is built on the inner or turntable side of the house.

Ample window area should be provided, to light the work benches and the interior of the house, and the windows should be kept clean. In too many cases this appears to be nobody's business, and the windows soon become obscured with dirt and dust on both sides, the washing being done only at long intervals. With a house 80 ft. wide, however, the outer windows alone may not furnish sufficient light, but as large an area of windows as possible should be placed over the doors, while skylights may also sometimes be necessary. The ventilation has an important bearing upon the lighting, as neither natural or artificial light will penetrate effectually through an atmosphere loaded with dust and smoke, and perhaps made foggy by escaping steam. The light will be greatly improved if the interior is whitewashed or painted white, which can be done at very small cost by the use of a compressed air sprayer.

The lighting at night is often specially inefficient, the men having to grope their way around and to do their work at the benches or under the engines by the fitful light of torches, which diffuse their light but slightly and are very smoky. Oil lamps and gas jets are rarely satisfactory for roundhouse work. The electric light is by far the best, lamps being placed over the circular gangways and between the stalls. Incandescent lamps may be used exclusively (in groups or singly), or there may be arc lamps for a general lighting of the interior, and fixed and portable incandescent lamps to furnish light where specially required in cleaning, inspecting or repairing, either on the floor or in the pit. Drop lights may be fitted between the stalls, which can be lowered so as to throw light under the engines, but portable lights will always be required for work in the pits. The use of torches should be avoided as far as possible, as their light is very inefficient and they add to the smoke and dust. It must be borne in mind that roundhouse work goes on night and day, and that it is important to have the work done both properly and promptly, for which purpose good light is required at all times.

The ordinary ventilation of a roundhouse is usually effected by roof openings or monitors, but in some cases the smokejacks for carrying off the smoke and gases from the engine stacks are relied upon also for general ventilation. On many southern railways, however, a continuous ventilator or monitor at the ridge of the roof serves both for general ventilation and to carry off the products of combustion. The report of the American Railway Master Mechanics' Association, already mentioned, recommends ventilators over alternate stalls at least, the minimum dimensions to be 3 × 4 ft., with a height of 2 ft., the sides being fitted with slats or louvres. In the northern states, these ventilators should have drop doors to close the roof opening during the winter.

The roundhouse roof should not be made too low, with the idea of reducing the space to be heated, as the low roof is likely to make the building smoky and dim. Ventilation by the blast system is sometimes employed, as in the Clinton roundhouse, already referred to. This system is also used for heating the house during the winter, as noted further on.

The smokejacks over the engines are very often in bad condition, and when they are simply fixed pipes, with a trumpet mouth at the bottom, they are frequently inefficient, air currents within the house diverting the smoke, etc., before it reaches the smokejack. The most satisfactory type of smokejack has a telescopic lower section which can be dropped right over the engine stack. In one smokejack of this type (Eng. News, Oct. 25, 1900), the telescopic section fits directly upon the top of the stack, with an air-tight joint, thus preventing any escape of smoke or gas into the house, and giving a good draft for firing up the engine. A hinge joint allows the bottom section to swing, so that it will not be pulled down or damaged in the event of an engine being moved before the smokejack is raised. The smokejacks should have dampers so that they can be closed when engines are not standing under them. Otherwise, with a heating and ventilating system, there will be great waste of air, and consequently of power and fuel. The damper should also be closed when an engine that is not fired up is standing under it, so as to prevent a draft of cold air through the firebox and tubes.

If steam is blown off in the house, the moisture will collect on the smokejacks and roof members, and drip upon the engines, the dirty water and wet soot soon causing injury to the planished iron boiler jacket. To prevent this, steam should be blown off through a pipe connection at the dome, the pipe being either led down to an underground main or up through the roof. A plan adopted on the Baltimore & Ohio Southwestern Ry. is to have a fixed pipe over each stall, extending through the roof like a smokejack, but having at its lower end a hose or metallic joint for coupling to a blow-off elbow on the engine dome. One objection to this latter plan is said to be an increase in the time of blowing off, unless large pipes are used. With a drop smokejack and a steam blow-off pipe to each engine the difficulties of keeping the house clear and well ventilated would be greatly reduced, and the fuel required for the heating and ventilating system would be correspondingly reduced.

The heating is usually effected by steam pipes, or by a hot air blast system, the latter having many advantages. In a building having so many openings as a roundhouse, steam pipes do little more than heat the air locally, while the pipes in the engine pits make them uncomfortably hot for the men working under the engines. These pipes are also liable to frequent injury by tools, etc., being dropped upon them, so that they are often leaky, making the pits both damp and hot. In fact, trouble is generally experienced from leaky pipe where steam heating is employed in roundhouses. With the hot-air system, the air is blown into the building by a fan and is distributed over the entire area of the building, tending not only to exclude cold air, but also to blow out all smoke, gas, dust and steam. Branch pipes, fitted with valves or dampers, are led into the sides of the pits, so that when an engine comes in covered with ice and snow the blast can be turned on, and the hot air rising from the pit will soon thaw out the engine. For very bad cases, where an engine comes in coated with ice and is wanted again quickly, a steam jet with a hose may be used for thawing and cleaning, but this spreads steam all over the house, and is a practice not to be recommended except for emergency use.

The facilities provided for blowing out and washing out the boilers are frequently very inadequate, resulting in considerable loss of time, discomfort, and a generally "sloppy" condition of the floor. The work can be done much quicker if hot water is used, and with less trouble from leaky tubes, than when cold water is let into the boiler as the hot water runs out. The cold water is found to settle to the bottom of the boiler, causing shrinkage strains, which may prove troublesome. Care should be taken, however, to have the hot water in sufficient quantities ready and easily obtainable, or the men will probably resort to the use of cold water for the sake of quickness and convenience. The water must not be too hot, or its use will be objectionable to the men, while the steam arising will prevent them from working to the best advantage. The steam from the engine may be blown off by a pipe through the roof, as already noted, or it may be piped to a main connecting with all the pits and led to a tank or cistern of water for washing out the boilers, thus utilizing the waste steam to heat this water. Where a stationary boiler is used for furnishing water for washing out and refilling the locomotive boilers, the waste heat from the furnace may be utilized for drying the sand for the engines.

Particulars of the methods employed on the New York, Ontario & Western Ry. for washing out and filling locomotive boilers at the roundhouses, have recently been furnished us by Mr. George W. West, the Superintendent of Motive Power. A locomotive boiler is located about the center of the enginehouse, and directly opposite this boiler is a "Little Giant" boiler washer. A 2½-in. wrought-iron pipe extends in either direction from this boiler washer to the extreme ends of the roundhouse, and opposite each pit is a T-connection, to which is attached a length of hose. This 2½-in. pipe is connected to the water supply from the city mains and also to the boiler washer, and the temperature of the water can thus be regulated as required. It is arranged to have the water about as hot as a man can hold his hand in without being scalded. The engines are all backed into the roundhouse, so that the pilot faces the turntable. The relief valve of the steam chest is removed and the boiler pressure is reduced to about 30 lbs.; the blow-off cock is then opened and the water is blown out of the boiler. This is found to give better results than blowing the boiler out under high pressure. The men immediately begin using the hot water from the boiler washer to clean the engine boiler, and then use the same water for filling this boiler. An apparatus attached to the compressed air plant is then dropped into the smokestack and creates an artificial draft. In this way, when necessary, an engine can be blown-off, washed out, and have steam up again in less than an hour. The steam blown off from the boiler is not now utilized, but it is expected in the future to utilize this steam in the winter for heating the roundhouse.

Steam for various purposes, such as for blowers used in firing up engines, is usually carried through roundhouses in pipes about 1½ ins. diameter, the steam being supplied from special boilers at the roundhouse or from those of the power plant. Compressed air is also distributed through pipes for use in operating jacks, hoists, and such portable tools as drills, riveting hammers, valve seat grinding machines, tube expanders, etc. For such work an air pressure of 100 lbs. per sq. in. is generally recommended. The steam and air pipes may be placed overhead, having vertical branches between the pits, with hose connection to be coupled up to the engine or the tools. As a rule, however, it is preferable to have all pipes placed in an underground conduit.

The engine pits should be about 50 to 60 ft. long, and 4 ft. wide, with depths varying from 2 to 3½ ft., according to the style of engine to be accommodated. The deeper pits are used for engines with small wheels and deep fireboxes. The floor of the pit should be of brick or concrete, laid on gravel or broken stone. It should either be convex (with a crown of about 3 ins.), forming two side gutters, or should slope slightly to one side for drainage. A pit with a concave floor, collecting the water, is very disagreeable for men to work in. The floor of the pit will also slope to one end, draining into a circular pit or conduit around the inside of the house, which connects with a suitable outlet or with the sewer system of the shops and yards. This pit may also be used to advantage for carrying all steam, air, water and blow-off pipes, etc. It may be of brick or concrete, and should have removable covers to facilitate cleaning and inspection. The walls of the engine pits must be thick enough to carry not only the stringers or blocks for the track rails, but also to support the timbers outside the rails, upon which are placed the jacks when any lifting is to be done.

Drop tables are desirable in one or more of the pits, for economical work in making quick repairs where wheels have to be removed, especially in connection with heavy engines. The drop pit extends laterally between two of the engine pits and may have a loose cover. The engine track is carried across it by short rails or stringers which can be removed. A jack car or drop table running in the engine pit takes the axle and its wheels, lowers them clear of the engine, and then runs into the drop pit. The wheels are raised either in the next engine pit (if unoccupied) or in the space between the tracks. Both engine and drop pits should be well drained and kept dry and clean. They should be provided with connections for portable electric lights.

The turntable is one of the very important features of the roundhouse, and should be kept in good repair and be frequently inspected, as any accident to the turntable may tie-up a house full of locomotives and interfere seriously with the traffic. Long tables are more easily operated than short tables carrying the same load, and where large engines are in use the turntable should be 60 to 70 ft. long. At large roundhouses, it is poor economy to rely upon manual power for turning the engines, and a power system not only allows any one engine to be turned promptly, but greatly facilitates the work of caring for a large number of engines. If electric power is used in the shops, the current may well be used to operate a motor on the turntable; otherwise, a compressed air engine or a gasoline engine would be both convenient and economical. The turntable pit should be well drained and cleaned, and kept clear from dirt and refuse. Between the turntable and the roundhouse there should be a space wide enough for an engine and tender to stand clear of the table and the doors. The large new roundhouse at Clinton (C. & N. W. Ry.), described in our issue of Feb. 14, 1901, has a turntable 70 ft. diameter and a space 103 ft. wide between the table and the house, while the clear inside width of the house is 81 ft. 6 ins.

There is some diversity of opinion as to whether the engines should stand in the roundhouse with the smokebox or the tender towards the turntable, but the weight of opinion seems to be decidedly in favor of the latter arrangement, the engines heading into and backing out of the house. One reason for this is that the work benches are placed against the outer wall, and as the majority of the repair work is on the engine itself, it is desirable to have the engine as near as possible to the benches. This arrangement also puts the work in better light, and causes less obstruction to the general lighting of the house, while it gives more room for working, since the spaces between the stalls are wider at the outer side of the house. If the smokejacks are about 18 ft. from the wall, there will be plenty of room for removing pilots and for working on the front end of the engine.

With the increase in the size of modern locomotives, many of the parts are now so heavy that they cannot conveniently be lifted or carried by one or two men, so that means must be provided for handling steam chests, dome covers, sand boxes, pumps, rods, etc. For this purpose, overhead trolleys (with pneumatic or electric hoists), portable cranes, jacks, hoists, etc., must be provided. In the trolley system, there might be a circular runway near the work benches, with radial lines extending between the stalls or over the pits, these being connected to the circular line by Y-curves. Special devices are often used. On the New York, Chicago & St. Louis Ry., a small portable crane is attached to the smokestack for handling steam chests and covers. A similar device, placed on the running board and clamped to the hand rail, is used to raise and lower the air-brake pump. Portable tools, such as jacks, vises, etc., mounted on wheels, are in use, and are readily moved to any place required.

For lighting fires, a mechanical device, consisting of a burner from which oil is sprayed by compressed air, is very useful, doing its work more quickly and effectively than a fire of kindling and waste alone. A drop smokejack gives a good draft and carries off the products of combustion. Where this is not used, the draft may be induced by suspending within the smokestack a ¼-in. pipe having its lower end bent up to form a U, and having a 3-16-in. opening. The upper end of the pipe is connected to an air pipe or steam pipe, and the vertical jet of air or steam in the stack acts as a blower.

The ashpits, coal trestles or platforms, water tanks and water columns, sand houses, etc., should be located conveniently near the roundhouse to facilitate the work of getting an engine ready for another tour of service. Some instructions as to the proper location of these outdoor facilities were given in the report of the committee on Yards and Terminals, of the American Railway Engineering and Maintenance of Way Association, an abstract of which report was given in our issue of March 14, 1901, and these instructions are given below:

Coaling, Ash-Pit, Sand and Engine Tracks.—The engine-coaling facilities are usually located on the track leading to the engine house. Water and sand should also be taken at the same time as the coal, where it is possible to arrange this. The facilities for supplying coal, water and sand are sometimes provided on the outgoing engine-house track, as well as on the incoming track. It will be of advantage to provide a run-around track, so that switch engines may clean fires, take coal and water and pass around waiting road engines.

LETTERS TO THE EDITOR.

Graduation of Level Rods.

Sir: Most engineers are familiar with the defects of the ordinary New York level rod when it is desired to read the upper half from the instrument or to measure the depth of a pit or any direct length from the upper half. We have lately graduated the top half ourselves, on the back of the rod, and use it now without target quite frequently. It beats a 12-ft. single rod for any work except bench leveling, and furnishes one more instance of what manufacturers might do, if it were not to their interest to make a separate rod, Philadelphia style, for the trade.

Yours respectfully, Horace J. Howe, M. Am. Soc. C. E.
Asst. Engineer Rapid Transit R. R.,
231 West 125th St., New York, Aug. 17, 1901.

National Aid to Irrigation.

Sir: In the matter of national aid to irrigation of the arid West, as discussed in your issue of Aug. 8, the writer ventures to suggest that the provision for revenue to defray the cost of irrigation works specified in the draft of the proposed bill submitted with Mr. Bond's letter is totally inadequate to initiate and sustain an effective and comprehensive policy of construction and development. You will observe that the bill provides one source of revenue only, viz.: sale of public land in the arid states, and no work can be undertaken until such sale is made. Evidently development would be limited to the value sold. The land in its arid condition has no market value, but an arbitrary one of $1.25 per acre, consequently it is not salable. Sales are confined to timber land, mineral land and land already susceptible of some sort of irrigation. All combined cover but a small portion of the arid area. Even this small revenue area is largely acquired, and the public lands now on the market are largely desert pure and simple. Before these lands can be occupied they must be reclaimed. The proposed bill would attempt to reverse this condition and therein lies a fatal defect. Under its operation, there would never be money enough in the Treasury to attempt more than a superficial development of small and comparatively unimportant areas.

You will note that total expenses are to be met by sale of desert land covering everything from preliminary examination to complete irrigation systems.

For the moment, let us assume that the 600,000,000 acres in the arid territory all belong to the public domain and are salable at $1.25 per acre as rapidly as the development of the 100,000,000 acres susceptible of irrigation may require. This would yield a revenue of $7.50 per acre reclaimed.

The cost of irrigation works independent of storage in the United States has been about $8.15 per acre. But it is conceded by all that future development must be through storage of flood waters in great reservoirs and the latter added to the cost.

In the arid West, 23 reservoirs, representing all classes of dam construction for irrigation, have cost an average of $21.93 per acre ft. Twenty-one projected reservoirs for the same purpose are estimated to cost $6.57 per acre ft. The great difference in cost is due to the fact that the former have been built on comparatively small scales and less favorable conditions where dams of given dimensions could not store the enormous volumes of water possible in the great projected schemes now to be realized. We take, therefore, the estimated cost of $6.57. But an acre foot is an insufficient average to irrigate properly. However, it will generally be found that ability to fill the reservoir more than once will supply the deficiency and that the capacity in acre feet is a very fair measure of the irrigable area.

Future development, therefore, must provide for storage at $6.57 and canal system at $8.15, or a total of $14.72 per acre. This is a somewhat crude, but a conservative estimate quite close enough for the argument. On the most favorable assumption, therefore, an expenditure of $14.72 is required, while the revenue can not exceed $7.50. But it is altogether probable that, for every acre reclaimed, not more than one will be sold. The account would then be:

Cost, reclamation 100,000,000 acres	$1,472,000,000
Receipts, sale of 100,000,000 acres	125,000,000
Deficit	$1,347,000,000

Rather, our development would be limited to $125,000,000 or 8,424,000 acres of a possible 100,000,000.

It is quite evident, therefore, that the lands, to pay reclamation, must be on the basis of their value after, not before, recovery from arid conditions. Obviously, the advocates of exclusive national control of this stupendous proposition have altogether the better of the argument from the vital financial standpoint, for the conditions imperatively require a long time advance of vast sums of money, to be repaid in the enhanced value of the lands, and dependent entirely on a prior construction of the irrigation works. Financially, the arid states are unable to undertake the work. It may well be a question if the national government should do so. Undoubtedly, the answer, on broad generalizations, would be in the affirmative, for the reclaimed land will readily average in value $30 per acre and, eventually, a higher price than the most valuable farm lands in the most favored sections of the Mississippi Valley.

In the meantime, no additional impediments should be placed in the way of private enterprise. To the latter is due the credit of the irrigation development in arid America.

That private capital has not reaped the measure of success deserved and possible in this work is due principally to the deplorable muddle and conflict of water-right laws and legislation by which hostile interest have involved many legitimate and highly-promising schemes in endless litigation. But these difficulties would also confront and obstruct even a national policy of administration and the first great work should be their removal. This done, private enterprise would also succeed. Granted that a national policy of irrigation development is inaugurated, who will say that it shall be an exclusive one hastening or retarding the growth of the West by its pleasure or ability. The work to be done calls for all legitimate and effective resources. The national government can make no better beginning than by nipping the adverse influence and activity of some of its own departments, notably those of War, Justice and State, in some important cases.

Yours truly, J. L. Campbell.
Koeltztown, Mo., Aug. 12, 1901.

Is the Smelting of Iron Ore by Electricity Practicable?

Sir: My attention having been called to the article published in your issue of May 2, 1901, under the heading "Is the Smelting of Iron Ore by Electricity Practicable," I have perused the same with much interest and attention. The preamble of that article is to my mind admirable, but I ask your permission to point out that your conclusions have the fatal defect of having been founded upon figures and conditions which are hardly correct and fair to the electrical process. I am willing to accept as correct such figures as you have given in respect to the cost of smelting by the old process, although such figures seem to be somewhat below the average cost.

As to the electrical process, you state that electrical

power is worth anywhere from $20 upwards per horsepower per year. To this statement I am obliged to object. Coke can be made, in certain places and under certain conditions, at a very low rate per ton, so also can electrical power be developed and rented at a very low price per horse power. I know of a case where electrical power can be developed and could be leased at a rate as low as $6 per horse power and yet pay a fair interest on the investment. I know where a few hundred thousands of horse power (electrical) could be leased at $10 per horse power, were iron manufacturers prepared to lease the power for a good term of years.

At this point I would point out that while, through strikes and other causes, the price of coke is liable to be advanced the price for power will remain stationary.

You claim that the coke required, under the best conditions, to produce 2¾ tons of pig iron costs $5.50, and that under like conditions one electrical horse power per year will also produce 2¾ tons of pig iron. I accept your figures as the basis of my argument. We therefore apparently have a cost of $5.50 for the coke process against $10 for the electrical process. But as in the large majority of cases it is necessary to bring the iron ore to the coke and as this need not be the case when electricity is used, in order to obtain a fair comparison, it is necessary to add to the price of coke the cost of assembling the iron ore and the limestone, and to add to the cost of electricity the cost also of assembling the ore and limestone.

It has been claimed that the cost of freight on the iron ore and on the limestone required to make 1 ton of pig iron smelted in Pittsburg is no less than $2.70, so that the cost for 2¾ tons will be no less than $7.42, which added to the cost of coke makes $12.92. Now, when electrical power is generated near where iron ore and limestone is found, the cost of assembling is reduced to 42 cts. per ton pig iron or $1.15 for 2¾ tons, which added to $10, makes $11.15, and in some cases the cost of assembling is even lower than this.

Again, iron mines which are anywhere near the coke, are held for sale at high figures, whilst those near the water powers can often be purchased for a mere song.

But I claim other advantages for electrical smelting as follows: (1) The first cost of the plant which uses electricity is very much lower; (2) the cost of repairs is less; (3) less time is lost through stoppage for repairs; (4) the furnaces having to be closed down through strikes or bad trade, less damage is done to the furnace and they can be restarted on a shorter notice; (5) the electric furnace requires for a given production fewer men and the proportion of these who must be skilled men is less; (6) a reduction of sulphur—the sulphur in the coke being done away with; (7) a flexibility and a regularity in the working of the electrical furnace not to be obtained in the coke furnace; (8) a further saving can be secured in the process of converting the iron made in the electrical furnace into steel. I claim, given an electrical furnace which will produce 2¾ tons of iron per E. HP. per year and which will produce iron which when converted into steel will be found merchantable; given water powers of sufficient magnitude, say from 50,000 HP. upwards at low water, which water power can be developed into electrical power at $10 or less per E. HP. per year; given such a power situated near iron mines and limestone, that electric smelting could produce steel cheaper than steel can be produced by the old process. Such water powers exist, such iron ore and limestone deposits exist; all that is now wanted is the right furnace.

It must not be forgotten that year by year the ore which is to be found near to the coal is being used up and will in time become exhausted and that new conditions are thus being created.

The "Journal of Commerce," however, need not worry about the United States Steel Co., or any possible deterioration in the value of their present plant working the old process.

It takes time to develop large water powers, and the first powers so developed and used for the electrical smelting of iron ore and converting into steel will not affect the price of steel; any saving made will be so much extra profit. The number of water powers available and suitable for electrical smelting are not so large but that the United States Steel Co. is quite capable of taking care of them and of using them to advantage.

I look upon electrical smelting and converting into steel as being a process very suitable for certain descriptions of steel, and it is possible that the process, when perfected, will be used for the production of those descriptions of steel only, leaving the old process in undisputed command of the other sections of the great trade of steel making. When Bessemer first made public his now well-known process of steel making, he was laughed at. Let new ideas be looked into squarely, and let them not be put aside just because they are new.

Yours truly, Louis Simpson.

Ottawa, Ont., Aug. 12, 1901.

(Of course, if water powers exist where electric energy can be developed at so low a cost as our correspondent states, our comparison of the blast furnace and a hypothetical electric smelting process would be subject to the correction indicated. We think it well, however, to add a word of warning that in computing the cost of electric power all the items of cost should be included—not only interest on the investment, cost of operation and repairs, but a suitable allowance for depreciation. There are scores of electric plants in this country which have proved a financial failure simply because their projectors did not make sufficient allowance for the depreciation which the plant would inevitably undergo.

As to the "other advantages" for electric smelting which our correspondent claims, the first item named (cost of plant) shows an enormous disparity in favor of the blast furnace. A modern blast furnace, to produce 150,000 tons of iron per annum, can be built, we believe, for very much less than a million dollars, in round figures. An electric current producing plant capable of a similar output would have to generate about 55,000 HP. (using the figure of 2¾ tons output per HP. per annum, which our correspondent accepts). If we assume the very low figure of $100 per HP. as the cost of penstocks, water wheels, power house, dynamos, and everything else needed to furnish electric current to the furnaces, we have a total investment of $5,500,000 HP. In addition to this would be the cost of the furnaces themselves to utilize the current. As no such furnace as yet exists, the cost is, of course, indeterminate, and it may be added that until some such furnace has been invented and tested, Mr. Simpson's other claims as to the superiority of electric smelting over the blast furnace can hardly be accepted. It is to be borne in mind further that in our discussion we assumed a hypothetical electric furnace which should utilize nearly all the energy of the current. Existing forms of electric furnaces, such as those used for calcium carbide or carborundum production, are far from doing this. Notwithstanding the points raised by our correspondent, therefore, we see no more possibility of electric smelting competing with the blast furnace than before.—Ed.)

Notes and Queries.

H. V. S. desires the address of persons familiar with manufacturing processes in which ground wood pulp is utilized for other products than paper.

Correction: In the article on "Chain Belt Conveyors for Wood Working Plants," in our issue of Aug. 8, the lettering on the sections, Fig. 3, was unfortunately put on upside down, and this was not noticed until too late to be rectified. The side facing the bound edge of the page is the bottom of the cut, with planks and uprights forming the sides of the troughs. One trough has a stationary floor, over which travel the flights, while the other floor has a continuous traveling floor.

Mr. Geo. L. Wells, of Dunkirk, N. Y., writes:

The following may answer the inquiry of L. C. Q. in your issue of Aug. 1: Lay off chords of 215 ft. on one of the rails of the curved track and measure the middle ordinates. The middle ordinate so found in feet will represent the degree of the curve. Thus:

Middle ordinate of	1.0	ft. on	215	ft. chord	=	1°	curve.
"	"	"	1.5	"	"	"	"	= 1° 30′	"
"	"	"	2.0	"	"	"	"	= 2°	"
"	"	"	2.25	"	"	"	"	= 2° 15′	"

This rule has the same grade of accuracy as that of dividing the radius of a 1° curve by the degree of any other curve to find the length of its radius.

BALLASTING NEW RAILWAYS.

When a new railway is completed and ready for the track the roadbed is necessarily in a more or less unstable condition, the banks not being consolidated and the slopes of both banks and cuts being liable to wash and slip, while the ditches in the cuts are liable to become obstructed so that they will not afford proper drainage to the roadbed. To attempt to make a track suitable for heavy and fast traffic on such a roadbed by the use of a thin bed of good ballast may be an expensive proceeding, as much of the ballast will inevitably be wasted by going over the narrow banks or sinking into the soft roadbed. In many cases it may be better economy to keep the road well ballasted with plenty of good earth until such time as the roadbed has become consolidated enough to be fit for the permanent ballast. This view of the case is set forth in an interesting manner in a recent article in the "Roadmaster and Foreman," by Mr. J. C. Rockhold, Roadmaster on the Atchison, Topeka & Santa Fe Ry.; an abstract of which we give below:

Is the practice of putting ballast on new roadbeds wise or expedient? I unhesitatingly and emphatically say "No." In most cases the new road goes into "the enemies' country" for its business, and has as its competitor an "old line" that has passed through the horrors of construction and reconstruction, has rails of 70 or 80 lbs. per yd., has some sort of good ballast, a well-settled and drained roadbed, and an established business. Just as soon as the last spike of the new line is driven, the passenger and freight departments begin reaching out after business, and in order that they may not be handicapped in their dealings with the public, insist that the road be ballasted at once. Under pressure, the maintenance-of-way officials, with their hands full of incomplete construction matters, are compelled to organize a ballast force, with the usual retinue of steam shovels, work trains, etc., and begin the work of piling ballast on narrow fills (a large portion of it finding its way to the base of the embankment), and clogging the wet cuts, where no attempt has been made to subdrain or widen the narrow, ragged ditches left by the team and scraper brigade that preceded them. The work is pushed forward day and night and the entire line is galvanized with a thin coat of ballast.

For a short time the new track "rides" finely. Every one goes about with a benignant smile on his features, and even the roadmaster thinks he is safe in taking a little relaxation and he and his wife go to the mountains or sea shore, or "back to the old home." About this time the weather observer returns from a trip to the interior and gets down to business at once, warning the public that an "area of high pressure is forming in a certain latitude," and a storm of unusual magnitude is brewing. Finally it sweeps down from the north pole on schedule time, and ye gods and fiends, how it rains! For a week the storm center hovers menacingly near the grade stakes of the "new road." Then the trouble begins. The roadmaster receives an imperative summons from his superior to return at once. The new road, as well as its officers and employes in the ranks, are untried quantities in an emergency. No one knows where to expect trouble, and, as usual, it is the unexpected that happens.

What an awful change a few short weeks have wrought! Cuts full of mud, fills settling, track out of line and surface, ties decorated with wheel marks, and this, too, mind you, on a "ballasted track." The function of ballast is to provide a dry and stable foundation for the track to rest upon, and is supposed to be impervious to the ordinary effects of rain and frost. The blue prints in the engineer's office showing standard section of this roadbed represents the top of roadbed as being oval in form. The ballast resting on this oval (or "crown," as it is called by trackmen) allows the water to pass through ballast and drains it off over the edge of the embankment, thus leaving the roadbed beneath the ballast dry and solid.

But how woefully far apart are theory and practice in this instance! The real condition is something like this: The roadbed being in a state of settlement, when ballast was inserted, offered slight resistance to the heavy ballast, and heavier equipment. The inevitable and logical sequence was that ballast sunk into the new fill, and when the water passed through ballast, instead of a "crown" to shed it off, it found a trough instead, which had inadvertently been constructed for its reception, and the water thus confined quickly transforms the earth beneath the ballast into a batch of mortar. If on a grade, this trough carries the water on and finally brings up on a high fill, a dam having been thrown in its path in the form of a bridge abutment. Its progress being effectually checked it "proceeds to stand still," and the embankment begins the work of absorption.

When the latter has soaked up everything in sight it begins to act queer, and have "spells." Sometimes a chunk the size of a box car takes a notion to move. In such cases it never waits on the order of its going, but goes at once, and ballast and track often follow it to the bottom of the fill. In ordinary cases, however, the ballast sinks into the soft fill; the foreman soon exhausts his scanty supply of ballast on the shoulder in the hopeless effort of holding his track up to grade, and then resorts to the makeshift of driving shims under the ties. These follow the ballast down into the mud, and the next rain, which is due about this stage of the game, follows the shims.

The roadmaster rides day and night, and wastes his energy writing slow orders for trains and "butterflies" to the foremen, which are supposed to be instructions to get after sundry and divers low joints and fix at once, but on account of the violent oscillation of the rear car his messages, instead of being perfect specimens of chirography, have more the appearance of ancient hieroglyphics, or antediluvian bird tracks in the sand than modern penmanship. These "butterflies" have the effect of holding the gang idle for an hour, while each one tries his skill at working out "the old man's Chinese puzzle." The pile driver and wrecker are kept under steam continually, and the track department, from the chief engineer down to the man who holds the post of honor and "lies the car," know what real grief and hard work mean.

The management, looking over the delay reports, accident reports and the appalling expense accounts, conclude there are a lot of weak sisters on this line that need clearing out, and the official ax is ground, and heads fly right and left. A reorganization of the maintenance-of-way department follows, and the first thing heard from the new officials is a vigorous kick for more help and more ballast, both of which are usually forthcoming; more ballast is piled on the new embankment, which has already clearly demonstrated that its burden was greater than it could bear.

This work of annual reorganization and semi-annual reballasting goes merrily on for, say, ten years, when terra firma is at last encountered at the bottom of the roadbed, and victory perches upon the banners of the management! But at what fearful cost has the battle been won! What wrecks strew the line! Not only battered engines and disabled cars, broken ties and twisted rails, but wrecked fortunes and ruined reputations.

This homely article is presented in the hope of inducing some progressive official to try the experiment of waiting five years for his roadbed to settle before putting in ballast, and thus avoid a greater part of the accidents, hard work, worry and expense previously referred to. On almost every road there is a good quality of sandy soil, free from clay, adobe or gumbo. Why not surface your track with this material until such time as the roadbed is ready for ballast, i. e., the embankments well settled; the cuts widened and terraced, and sub-drained where necessary, and the work of construction completed? With the material referred to a good safe, easy-riding track can be maintained at a minimum expense, and at the expiration of the time, specified you have a solid roadbed, for while earth will compress and settle from natural causes, yet the whole mass settles uniformly.

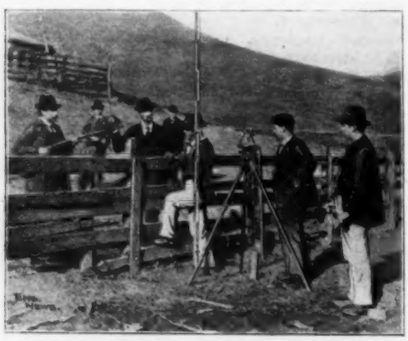
Track laid on such a bed with a top dressing of good soil and properly shaped so as to drain the water off instead of into the track, can be handled during the first few years of operation much more satisfactorily as regards safety and economy than with ballast. There may, of course, be exceptional cases where the above would not hold good, but the exception in this case would merely prove the rule.

TESTS OF FIREPROOF PARTITION BLOCKS and metal and plaster combined partitions will be made by the Building Department of New York city on Aug. 26, at 108th St. and Broadway. A supplementary series of tests will be conducted on Sept. 12 for the benefit of those concerns which are not able to enter the competition on Aug. 26.

AN OBSTRUCTION TO THE LINE.

We presume the photograph herewith reproduced will awaken memories of situations more or less similar in the minds of many of our engineer readers. In carrying on field work in any settled farming country one is pretty certain to run across occasionally the sort of man who persists in regarding the engineer as a trespasser, and in disputing his passage by force and arms.

It is very seldom that an encounter of this sort is photographed, however; for even though a camera be on hand, its owner is apt to be engaged holding up one or the other side of the controversy, and his services can't be spared even to press the button. We are not at all sure, however, that the man who is taking the picture is not the most usefully employed of any member of the engineer's party, to which we assume him to belong. Time is a great evaporator of wrath; and the man behind the gun and he of the brickbat are likely to feel some glimmering of their ridiculous position by the time their picture has been taken. We do not know the sequel of the encounter shown in the photograph, but we will hazard a guess that the bellicose individuals, after a little jollying from the transitman, and a promise not to injure the grass or break down the fence, concluded that the surveyors were not bad fellows after all, and that it was not necessary to obstruct their work.



An Opportunity for Diplomacy.

NOTEWORTHY WATER STORAGE AND IRRIGATION WORKS OF SOUTHERN CALIFORNIA.

By Robert Fletcher, Ph. D.*

From the verdant Connecticut Valley to the semi-arid mesas, canyons and mountains of Southern California; from the home of Yankee industry to what was but yesterday the land of "poco tiempo" and "manana," all in less than five days, is not an ordinary experience. The variety and extremes of scene and incident are in themselves noteworthy; and when these are supplemented by a rare opportunity to inspect a great system of storage reservoirs and distribution works it is possible that some of the gleanings may interest the professional reader.

A general knowledge of the routes and attractions of the great trans-continental lines is now almost commonplace, and yet the educational value of a through trip can be realized only by actual experience. Without a thought of invidious comparison or disparagement of any other trunk line, we may say that the journey of 90 hours in the "Santa Fe Overland" train from Chicago to San Diego is a continuously impressive lesson in physical geography, natural history and first-class railroad building. The traveler must needs lift his hat in deference to the foresight, energy, patience and skill of the capitalists and engineers who have overcome the obstacles of mountains, rivers and deserts and joined these far separated regions by the proverbial "bands of steel," nearly 2,400 miles long, an unbroken railway line under one management.† Heavy rails on an ideal roadbed, rock-ballasted and nearly free from dust, afford constantly smooth riding. Either in the "tourist" or standard sleepers rest at night is better than at home under like temperature, because of the inevitable and abundant air currents in a moving train. The swiftly passing panorama includes the prosperous farms of Illinois and Missouri; the golden wheat harvests and vast corn fields of Kansas; the sun-scorched plains, suggesting the old-time "American Desert," the home of prairie-dogs, anthills, bunch grass and dwarf sunflowers; the smelters of Trinidad; the climb and descent of the mountains culminating in the Raton Tunnel, 7,600 ft. above the sea; a glorious view of the Spanish Peaks; the high plateaus of New Mexico, with their vast expanses and stretches of distant mountains, while the road profile is a succession of maxima and minima between 5,000 and 7,000 ft. of altitude; great "washes" of gravel, sand and rocky debris miles in width, and passages from one mesa-level to another through wild, deep, tortuous canyons with colored fissured walls and gullied slopes; shifting prospects of mesas, buttes and castle-rocks, the deserts of Arizona and California, with temperatures from 100° to 120°, the land of the cactus, yucca, sage-brush, coyotes and jack-rabbits, giving glimpses of "sand-spouts" or whirls which run even races with the train; the crossing of the Colorado by the great Cantilever bridge, the ascent through the passes of the lofty San Bernardino Mountains, and the sudden descent into the region of seemingly countless and limitless orchards of every sort of fruit to which the adjective Californian is applied; and at last the terminus on the beautiful San Diego Bay, which affords "one of the five great views of the world," where is Coronado Beach, with its ideal swimming baths and the simple but cosy accommodations of Tent City, or the more elegant entertainment of the famed Coronado Hotel.

In that so-called "distant corner" of our country we have striking examples of "corporate" activity accomplishing large results for the public weal. During many years Boston capital and pluck, acting under title of The San Diego Land & Town Co., have labored patiently and against many serious obstacles to ameliorate harsh conditions and develop the possibilities of a great country. The Spreckels interests, acting through the Southern California Mountain Water Co., have in hand extraordinary works for irrigation and town supply in the same region. Individual enterprise with small means is absolutely inadequate here; only large capital, wisely expended, can make it possible for the home-seeker to maintain himself in a land of chronic drought.

During the past 14 years rainfall statistics for the southwestern part of San Diego county have been carefully collected by Mr. Hiram N. Savage, M. Am. Soc. C. E., engineer in charge of the Sweetwater system and other works of the San Diego Land & Town Co., and consulting engineer for the Southern California Mountain Water Co. The Sweetwater basin has had practically no runoff for three years. This drought is unprecedented in 50 years of available rainfall records in this region. Average rainfall in vicinity of the coast is from 8½ to 10 ins. annually; this increases directly as the altitude to from 20 to 30 ins. in the mountains. From 1887 to 1900 the largest annual rainfall at Sweetwater dam was 15 ins. and the least 4.97. The largest runoff in the basin was in 1894-95, the year of the great flood, and amounted to 71,300 acre ft. (see Engineering News for Aug. 15, 1895). Usually streams begin to run early in January and cease late in June; the mountains, being generally under 6,000 ft. high, do not long retain snow; slopes are very steep; much rain is apt to fall in two or three consecutive days, and the runoff is then very rapid. Hence large impounding reservoirs which will retain the greater part of the storm waters and conserve a sufficient supply to tide over two or three consecutive dry seasons are now recognized as a prime necessity for the continued prosperity of the country.

SYSTEM OF THE SAN DIEGO LAND & TOWN CO.

The Sweetwater basin has an area of 186 square miles, and the reservoir, since the addition of 5 ft. to the height of the dam and other improvements by Mr. Savage, has a total storage capacity of 23,000 acre ft.* The acreage irrigated under this system has increased from 1,310 acres in 1891 to 4,650 in 1897. The annual use of the water has decreased with the experience of the irrigators from 500,000 to 600,000 gallons per acre per annum in 1888 to 350,000 to 400,000 in 1897. At the beginning of the irrigation season of 1898 the reservoir held only 2,500 acre ft. available; the daily demand for houses and lots was then 1,000,000 gallons. After reserving for the latter purpose and for evaporation, a mutual agreement on the apportionment of the balance became necessary, and is here stated to show how such matters have to be handled in times of stress: To alfalfa tracts, vegetable gardens and all orchards to which water was delivered previous to 1890 there was allowed 210,000 gallons per acre; to orchards planted in the successive years to 1895 and later, allowance beginning with 190,000 gallons for those of 1890 to 70,000 gallons for the new ones, the time of delivery to be at the option of the taker. The inevitable and increasing conflict between the buyer and seller of water under such conditions has been in full heat during much of this time. In the earlier days of operation of the system water was plenty, and wasteful habits ensued. When the company, with wise foresight, began to check extravagance and serve the allowances by meter the takers, as usual, made bitter opposition. It is a sad but very general trait of human nature that man as a water taker is unblushingly selfish, lightly esteeming the rights of his neighbor and blind to the fact that, as between him and the company, also, interests are mutual; for the company must keep the future in view and guard the interests of all. Many highly respected members of society will "appropriate," which, being interpreted, is steal, water beyond their proper share if it can be done judiciously. In this case the continuation of drouth conditions has had a very sobering and educating effect. The fight, how-

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†For descriptions of the Ft. Madison and Red Rock bridges see Engineering News for June 2, 1888, and Sept. 27, 1890. For the Sibley bridge and location over the Raton Mts., see Trans. Am. Soc. C. E., Sept., 1889, and October, 1879.

*See Eng. News, Oct. 27, 1888, for information relating to the original dam, and Aug. 15, 1895, for an account of the changes then in progress.—Ed.

ever, assumes the phase of a struggle for existence when a man's all is invested in an orchard or orchards of orange, lemon or other fruit trees.

The company began to develop water by pumping in 1898 and had two plants, with a total capacity of about 90 gallons per minute, used for irrigating two of their large orange orchards. With the exhaustion of the entire reservoir storage near the close of 1898, salvation for all concerned depended upon the success of a general system of pumping underground accumulations where they could be found.

A steam-actuated plant, with a capacity of 4,000,000 gallons per 24 hours, was installed three miles back from San Diego Bay, the supply being developed by a gang of 75 wells consisting of 3-in. pipe with strainers, and pumped down to a uniform depth of about 50 ft. Another steam-actuated plant, with a capacity of 1,750,000 gallons per 24 hours, was installed about two miles below the dam, supply being developed by a gang of 32 wells 50 ft. deep. These plants discharged respectively into the 30-in. and 24-in. main pipes of the distributing system. These main pipes being kept open into the reservoir, permitted storage accumulation, thus affording constant supply under good pressure throughout the entire distributing system for all purposes during the year. Two smaller gasoline engine actuated plants, each with a capacity of 500,000 gallons per 24 hours, were installed in the reservoir at points one and two miles, respectively, above the dam, supply being developed by driven wells and dug wells, and conveyed from the pumps to the intake at the dam by open flume. A daily irrigation apportionment was made on an equal basis, and the quantity, so apportioned was stored and delivered substantially as required to every acre of irrigated land under the system. The total quantity per acre for the season of 1899 thus developed and delivered amounted to about 125,000 gallons. Although this was somewhat less than that for the season 1898, the irrigators had benefited by experience and were able to obtain conspicuously better results. It had been customary to irrigate in shallow furrows with from two to six and eight furrows to the tree row, thus covering nearly the entire ground. It was found practicable, however, to reduce the number of furrows to two, or not more than four, to the tree row, and, by making the furrows deeper, the irrigation duty of the water was nearly doubled on account of the lessened evaporation. The irrigation was carried on from necessity up to nearly the first of December. The rainfall for the season of 1899-00 afforded, like its two predecessors, no runoff for storage, and the irrigation season of 1900 began in February. Additional pumping plants were installed at intervals of about one mile throughout the Sweetwater valley below the dam, and in the reservoir above the dam, and were operated independently, discharging into the mains, or auxiliary, as feeders to the existing plants, as circumstances dictated. As the season advanced, the plane of saturation throughout the valley was gradually lowered until it fell below the gravity suction reach of the pumps, as originally installed. During July and August pits and trenches were excavated, all pumps and suction mains being lowered about 15 ft. and connected with the same wells. Several efforts were made to develop water with deep wells. The material encountered, however, was too fine to admit rapid percolation, and gangs of small shallow wells were found to be more productive. Ten pumping plants were operated throughout the season of 1900, about 150,000 gallons per acre being developed and distributed uniformly to all the irrigated lands under the system. The San Diego Land & Town Co. has expended over $100,000 in constructing and operating emergency pumping plants during two years.*

Under the conditions here prevailing, Mr. Savage is greatly in favor of centrifugal pumps, operated by gasoline engines. Such a plant is easily installed, operated and moved, as may be required, and gives high efficiency. When the lift becomes too great for one pump, two are operated by working in two stages. The recent successful development of petroleum wells in Southern California makes oil fuel available and economical, and it is found very satisfactory in operating the steam pumping plants.

This drouth experience has also been substantially that of the San Diego Water Co. engaged in supplying the city of San Diego with water for domestic purposes, and of the San Diego Flume Co., which supplies Lakeside, El Cajon, La Mesa and Lemon Grove with water for irrigation purposes. The water company originally obtained its entire supply from wells in the deep-saturated sands in the lower San Diego valley, pumping same directly into the city distributing pipes under the Holly system.

The Flume Co. impounds water in the Cuyamaca reservoir, which has a limited drainage basin of only 11 sq. miles, and is located on the north side of the Cuyamaca Mountains, some 65 miles inland. Additional supply, when available, is had from the San Diego River by diverting the flow from the same into its flume at a point some 40 miles inland. The water from the Cuyamaca reservoir flows down the natural stream bed of Boulder Creek, a tributary of San Diego River, and is also picked up by the same diverting dam.

The Escondido Irrigation District, of 13,000 acres area, formed under the Wright Irrigation Law, constructed a system and put the same into operation in the year 1895, about 2,000 acres being brought under irrigation, supply for the same being taken from the natural flow of the San Luis Rey River, through an open conduit some 15 miles long to an impounding reservoir (formed by constructing a loose rock, plank-faced dam across a canyon), located some six miles north of the town of Escondido. The runoff from the San Luis Rey River (priority to a considerable flow belongs to the Indians of the reservation) has been very limited since the district works have been put into operation, and no attempt has been made to increase the supply to the irrigators thereunder.*

SOUTHERN CALIFORNIA MOUNTAIN WATER CO.

The typical impounding dams of this system are described by Mr. J. D. Schuyler, M. Am. Soc. C. E., in his recent "Reservoirs for Irrigation," to which the reader is referred for fuller details. Mr. E. S. Babcock, President of this company, and also of the Coronado Beach Co., and manager of the Coronado Hotel, conceived the general plan of this system and began construction in 1890. As will appear, it is exceedingly bold, both in the design and in the execution of the various constructions, and when completed will take rank as the most notable series of such works in the United States, if not in the entire world.

THE MORENA DAM AND RESERVOIR.—The initial of the system, in point of location and elevation, is situated east by south about 60 miles from the city of San Diego, at an elevation of 3,200 ft. The dam is a rock-fill structure, closing a canyon 80 ft. wide at the bed of the stream, with granite walls that ascend with a slope steeper than 1 to 1 for a height over 500 ft. In excavating for a foundation at the bottom of the canyon a fissure was exposed that extended down 112½ ft. before pinching out. A concrete masonry toe wall for the rock-fill dam was built from the bottom of the fissure up to the 30-ft. contour of the reservoir, the total height of the wall being 142½ ft. The dam is projected to impound water in the reservoir to its 150-ft. contour. The ultimate height of the structure, including the masonry toe-wall filling the fissure, will then be 262½ ft. The reservoir at 150-ft. contour will impound 47,000 acre-ft. The thickness of the rock-fill dam at its base is over 800 ft. The main body of the rock was shot into position by exploding at different times three enormous blasts, aggregating 250,000 lbs. of powder, and moving, it is estimated, 250,000 cu. yds. of rock. Boulders weighing hundreds of tons were thus deposited in the structure. Two Lidgerwood cable conveyors, installed 400 ft. above the bottom of the canyon, were used to convey small rock from the quarries. An outlet tunnel, 800 ft. long, has been constructed. The drainage basin has an area of 130 square miles, ranging in elevation from 3,200 to 6,000 ft., with a mean annual rainfall of about 34 ins.

THE BARRETT DAM AND RESERVOIR.—This is the key to the entire situation. It is located next below the Morena, at the junction of the Pine Valley Creek and the Morena, at an elevation of 1,600 ft. This dam will act both as a diverting dam of the water from the Morena reservoir and for impounding the runoff below the Morena and from the Pine Valley, giving it an independent drainage area of 120 square miles, having a mean annual rainfall of about 30 ins. The Barrett dam occupies a most favorable and commanding location, being at the lowest elevation from which the water from this combined area of 250 square miles of precipitous and rocky drainage area can be diverted by gravity to the city of San Diego. It is proposed to build the structure as a rock-fill dam with a steel core. The present masonry structure has a length on top of 150 ft., is 30 ft. thick at base, 13 ft. thick at top, and 35 ft. in height. It is proposed to construct the dam to the 175-ft. contour of the reservoir, which will then have a storage capacity of 48,000 acre-ft. An outlet tunnel, 8 × 8½ ft. in section and 800 ft. long, has been driven around the west abutment of the dam.

THE LOWER OTAY DAM AND RESERVOIR.—This is located on the Otay River, 22 miles southeast of San Diego, at an elevation of 400 ft. above sea level. It was the first construction work undertaken by the company, and was completed in 1897.* It is 565 ft. long on top, with a total height from the lowest foundation of 150 ft. It impounds water to the 130-ft. contour of the reservoir, which has a capacity of 42,000 acre-ft. The dam was first started as a masonry structure, 65 ft. thick at the base, and carried up to a height of 40 ft., from the lowest foundation, when the plan was changed and a rock-fill structure was built, having a built-up plate steel core, protected on either side by 18 ins. of concrete masonry. An outlet tunnel, 4 ft. in diameter, was driven from the reservoir 1,100 ft. to the Otay valley. The reservoir has a drainage area of 100 square miles, with a mean annual rainfall of about 20 ins.

THE UPPER OTAY DAM AND RESERVOIR.—This is located on the north branch of the Otay River, contiguous to the Lower Otay reservoir, but at an elevation of 559 ft. above sea level, and distant about 20 miles from the city of San Diego. The dam was completed to the 75-ft. contour of the reservoir, has a storage capacity of nearly 20,000 acre-ft., and will impound water at a somewhat higher elevation than the Lower Otay for the irrigation reservoir. The dam, a masonry structure, probably outranks in minimum section and minimum cost, considering its length and height, any structure of the kind ever built. It is 350 ft. long on top, 75 ft. in height from lowest foundation, 14 ft. thick at the base, and 4 ft. thick on top, curved upstream, with a radius of 359 ft. The reservoir will be filled with water by conduit from one of the higher reservoirs.

The four dams, making up the system, each of which are notable along different lines, have been designed by and constructed largely under the immediate personal supervision of Mr. E. S. Babcock, President of the company. Independent mains will be constructed from the mountain reservoirs to the local commanding storage reservoirs, which will be located near the bay and city of San Diego. It is proposed to give these latter reservoirs capacities of from 25,000,000 to 150,000,000 gallons each. Starting at the Morena reservoir, the water from it will run down the natural channel some ten miles to the Barrett reservoir, from whence, with the water impounded in the Barrett reservoir, it will be taken, as required, to Dulzura through a conduit, projected to have a capacity of 200 sec.-ft., or 10,000 miner's inches. This conduit has been carefully located and estimated on three different plans: Open cement-lined trench, wooden stave pipe, or a continuous chain of tunnels. The contour length of the section is 11¼ miles, but if the chain of tunnels plan is adopted this would be reduced to 8¼ miles. From the Dulzura terminus of the conduit, the water would flow through the natural headwater courses of the Otay River, a distance of some twelve miles, into the Lower Otay reservoir; from which reservoir a conduit is now under construction to the city of San Diego, which will have a total length of 20 miles.

From the Dulzura terminus of the great conduit there is projected a further continuation, consisting of wooden stave pipes, with a capacity of 75 to 100 sec.-ft., running around the easterly and northerly boundaries of, and commanding all the irrigable land of Jamul ranch and adjacent territory. This line would have a total length of 25 miles, terminating at San Miguel Mt., at the base of which a power station could be constructed. The water from the end of the pipe line would have a drop of 500 ft. to the power station, where, after using, it would be at an elevation of 600 ft. above sea level, and from which point it could be distributed by gravity via the Sweetwater dam to the city of San Diego, or to all the higher levels of Janal, Otay and National Grants and other adjacent lands, and, when not required for either city or irrigation uses, it would flow either into the Sweetwater or Upper and Lower Otay reservoirs.

*Quoted nearly verbatim from an article by Mr. Savage in "Water & Forest," San Francisco, June, 1901.

*See Eng. News, March 10, 1898, for article by Mr. Savage describing the dam and its construction.—Ed.

The Southern California Mountain Water Co. owns the Jamul Ranch, the Janal Ranch, and has acquired contract rights from the San Diego Land & Town Company to a large area of the Otay Grant and the National Grant, which, with the other adjacent lands, makes a total area of about 25,000 acres, some of the most attractive and best located land—from an agricultural, irrigable and scenic standpoint—in Southern California.*

The opportunity to verify and gain experience of these facts and conditions within the space of a few days was only made possible by the hospitality of Mr. Savage and the interests which he represents. No one can better do the part of genial host, and his other abilities are supplemented by such "skill o' horseflesh" as would stir the envy of the proverbial California stage-driver. Behind a four-in-hand of half-broken horses, such as the country produces, seated on a buckboard which had survived service in the survey of the U. S. Boundary Commission, with rations for man and beast and all other luggage securely tied on, heights and depths and the uncertainties of mountain roads had no terrors. Before operations could be begun in the Morena basin the company spent more than $30,000 in building roads. The road out of the basin rises 550 ft. in altitude, and then descends more than 1,800 ft. to the site of the Barrett dam, all within a distance of 13 miles, part of which is valley bottom. They get used to grades of 25% or more, both longitudinal and transverse, to ruts and gullies almost hub-deep, to stream "washes" with nearly vertical sides, and other conditions which our "speedway" experts would deem impossible. On the other hand, the road from Barrett dam to Jamul Ranch is a model of excellence and scientific location, having hard surface and uniform gradients, reminding the traveler of the best of the Swiss roads. About 300 miles of travel under such conditions, including a reconnoissance of a day and a-half over the line in Mexican territory, accomplished a very precipitate and extensive introduction to the region and its people, during eight days on the road.

The soil of the entire region is disintegrated and rapidly disintegrating granite; even the solid granite of the mountains is in such a crumbling condition in certain localities that tunnel driving is easy. Some of the formations afford a porphyritic rock which is hard but very seamy and readily breaks into fragments. Per contra, the Sweetwater quarries yield a granite of such excellent quality as to meet the requirements of the U. S. Government for building the San Diego breakwater. Certain grades of this natural detritus make fairly good road surfacing; other deposits furnish the typical adobe, that constructive material of prehistoric interest as well as present utility.

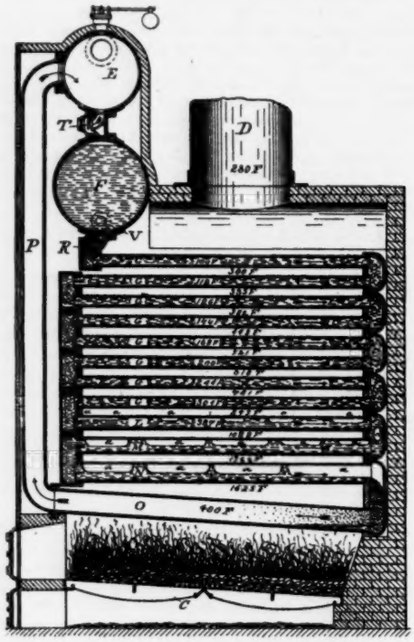
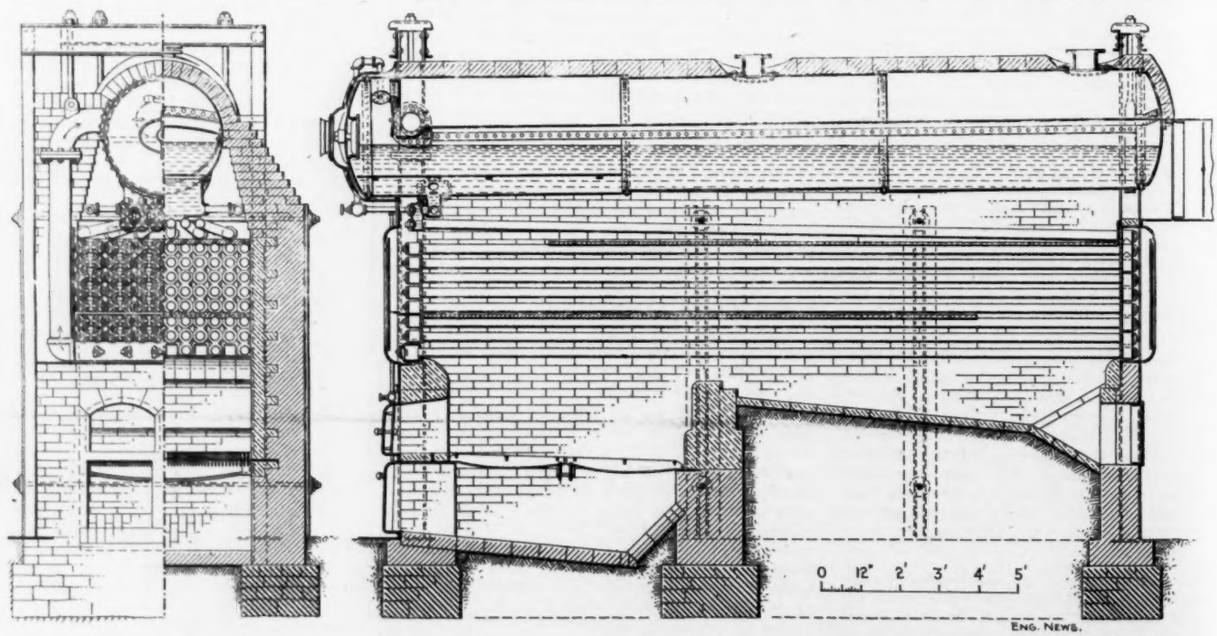


Fig. 1. Sketch Illustrating Method of Operation of the Parker Water-Tube Boiler.

In such a country, even an engineer cannot attend solely to cold facts and figures. The ruins of many old "missions," now being partly restored through an awakened public interest in their history, cause one to feel something of the glamor of romance and sentiment which Mrs. Jackson (H. H.) aroused not many years ago by her immortal "Ramona." And her graphic portrayal of the cruel wrongs done to an unresisting and unbefriended people prompt a kindly feeling towards the remnants and descendants of the Mission Indians and other natives which one meets in traversing the country. Moreover, opportunity is not lacking to indulge in what may be deemed strictly professional sentiment. This is afforded by a visit to the Mission dam, in the San Diego River valley, some miles above the school of the mission fathers, to which a well-built masonry flume carried the impounded waters. The dam, which is more or less than 200 ft. long, and visibly about 40 ft. high, is built of stone laid to a rectangular section with mortar of a hydraulic lime for which the "fathers" had found suitable material. The waterway or flumeway is lined with excellent brickwork, and all of the masonry, now about 120 years old, is nearly as firm and strong as if laid with a good quality of modern natural cement. But the open flume, of which there are some good remnants, has special interest because it has the same form of cross-section and proportions that are used in the practice of to-day. It was built of stone and brick-ware laid in hydraulic mortar. The curved invert was of baked brick or tiling; the sides above this flared outwards and upwards. We can appreciate the industry and patience of the fathers, and more especially of the neophytes, their mission Indians, which secured such substantial results—an old-time recognition of the value of industrial training in working for spiritual or moral ends.

Under the influence of the winter rains the natural fertility of the soil asserts itself. The country is covered with flowers and verdure, and all crops make phenomenal growth. In that "Land of Sunshine," which, in the region of San Diego Bay is also a land of wonderfully equable temperature, the flowers and plants of our northern clime are magnified; while various native flora, unique and often marvelous, astonish and charm the beholder. In a well-kept park or garden the climate and environment of a "land of perpetual youth" seem to be realized. Specimens of alfalfa plants are shown which attained full height in little more than three weeks. The Chambers of Commerce of San Diego, Los Angeles, etc., are crowded with magnificent exhibits of the various products of a soil which under irrigation renders such wonderful returns, like three or more crops of alfalfa per year. An instance of the scale of operations appears in the fact that a single proprietor not long ago let a contract for cutting and baling the hay on 5,000 acres.



Sectional End Elevation. Longitudinal Section.

FIG. 2. A WATER-TUBE BOILER WITH REGENERATIVE CIRCULATION SYSTEM.
John C. Parker, Inventor.

*The statements of the last six paragraphs, except for some abbreviations, are essentially as contributed by the consulting engineer to the publication before named.

The meteorological history of the region seems to establish a series of eleven-year cycles or recurring periods of abundant or excessive rainfall. Even the "disinterested" observer may be interested to note whether another such cycle will be duly fulfilled, and whether drought conditions will recur with more or less severity. Interest in such questions is rather widespread in many other sections of our country, where the conservation of storm water or runoff from irregular rainfall, to tide over periods of privation, has become a problem of vital importance. Hence the works to which attention is here directed, the development on so great a scale by large capital of the inherent possibilities which, when realized, will bring prosperity and enlargement to many waiting communities, should attract keen interest far beyond the boundaries of their operation.

TWO NEW WATER-TUBE BOILERS.

Suppose it is desired to extract from a stream of hot fluid as much as possible of the heat it contains and transmit this heat to a stream of cooler fluid. To state the problem in practical terms, let the hot fluid be the stream of hot gases from a boiler furnace and the cooler fluid the water inside a steam boiler. It will be found on a little study that the most heat will be extracted from the hot gases, and they will be discharged at the lowest temperature, if they are made to flow in a stream parallel to the stream of water which is to be evaporated but in the opposite direction. In this manner the gases in the latter part of their course will be in contact with the cool feed water just entering, and their heat will be more fully abstracted than if they were in contact with water at the ordinary boiler temperature.

This method of operation gives the greatest mean difference of temperature between the heated and heating fluids throughout the apparatus, and hence the heating surface is operated with maximum efficiency. This method of working may be called the regenerative system.

In ordinary types of steam boiler the temperature of the contents of the boiler is very nearly the same throughout and the flue gases are necessarily as hot as or hotter than the steam produced. When an economizer is added some approach is made to the regenerative system.

Another example is the practice on locomotive boilers of discharging the feed water near the front end of the boiler, where it is supposed to come in contact with the gases just before they leave the tubes. Whether this really accomplishes anything of practical value in the way of economy is very doubtful.

There is shown in the accompanying illustrations a new type of water-tube boiler in which an attempt has been made to apply the regenerative system of operation to its fullest extent. Fig. 1, reproduced from a patent drawing, shows diagrammatically how this is accomplished. The feed water is supplied to the drum F, from which it descends in series through the tubes G, G....., G, L, M, and N, to the pipe O, where it is supposed to be completely converted into steam. The latter ascends by the pipe P to the steam drum E.

The gases arising from the fire upon the grate at C pass among the tubes, traveling upward in the opposite direction to the water and steam, and finally escape through the flue at D. The figures in the tube and gas spaces are intended to illustrate the progressively increasing temperature of the water as it descends and the decreasing temperature of the hot gases as they rise, the latter being supposed to escape at a temperature below that of the steam formed.

The boiler and setting as actually constructed are shown in Fig. 2. As may be seen, there are six paths by which the water passes from the water drum to the steam pipe, each path consisting of two vertical rows of tubes. The water turns horizontally in the headers at the front end and vertically in those at the rear. In order to save space the steam and water drums are combined into one, which is provided with a horizontal partition to separate the water and steam.

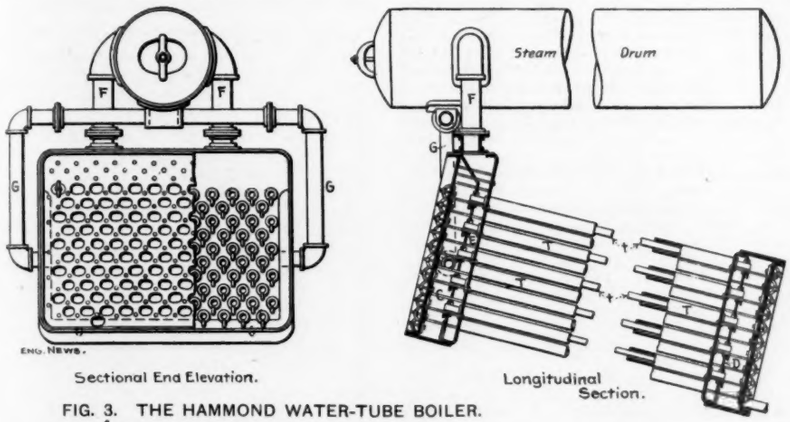


FIG. 3. THE HAMMOND WATER-TUBE BOILER.
Built by the Hammond Iron Works, Warren, Pa.

Any water carried over with the steam drains back into the water compartment through a check valve. The latter is intended to prevent water being "lifted" from the water compartment into the steam compartment by a sudden reduction of steam pressure. A restricted by-pass between the two compartments ensures the general equality of pressures.

A check valve is also placed at the point where the water passes from the water space into the tubes. This is to prevent backward circulation of the water. When no water is being withdrawn from the boiler the levels of the water in the steam pipe and in the water drum will, of course, be the same, but when steam is formed it will of necessity have to escape through the steam riser, and when the boiler is in full operation it is claimed that very little water enters the latter.

If this happens, of course any sediment contained in the water must be deposited in the tubes. To remove this sediment the inventor closes the by-pass valve and reduces the steam pressure. Evaporation then begins in the water drum and throughout the tubes and forces a column of water through each element. It is said that all sediment is thus scoured out of the tubes and carried up with the water to the steam drum. This automatic flushing can be effected any time a drop in pressure occurs.

From the steam drum the water and sediment drain back into the water drum as soon as the by-pass valve is again opened. It is said that no mud or scale lodges in the steam drum, but is invariably found in a heap directly beneath the check-valve passage to the water drum, where a connection is provided for blowing it out. The water drum is slightly inclined to prevent the loose sediment from being carried into the tubes.

The hand-holes in the headers are circular, and have the same diameter as the inside of the tubes. The circular hand-hole permits the covers to be ground to their seats to stop leaks while the boiler is in operation. Tubes are drawn out between the headers and not through them. Square openings are left between the corners of the headers, through which a steam nozzle may be introduced for blowing soot and ashes off the tubes.

Tests have been made by Prof. H. W. Spangler, M. Am. Soc. M. E., of the University of Pennsylvania, upon a boiler of this type of 175 nominal HP., at the shops of the Delaware River Iron Ship Building & Engine Works, at Chester, Pa., where it was in use supplying steam hammers and shop engines. The heating surface amounted to 1,760 sq. ft., and the grate surface to 36 sq. ft. George's Creek coal was used. The results obtained are given in the accompanying table.

Results of Tests of 175-HP. Parker Boiler.

	Tests by Prof. Spangler					Forced draft by J. C. Parker.	
Dry steam per lb. of combustible, from and at 212° F.	12.54	11.65	11.70	11.81	12.39	11.95	11.41
Average boiler pressure, lbs.	87.3	94.2	95.1	94.6	93.8	101.2	101.4
Temperature of feed-water, degs. F.	49	50	51	52	52	53	53
Moisture in steam, %	1.0	0.8	0.7	0.7	0.7	0.7	0.7
HP. developed	128.1	138.0	149.0	127.2	132.8	236.9	265.0
Heating surface per HP.	13.7	12.7	11.8	13.8	13.2	7.4	6.6
HP. per sq. ft. of grate	3.55	3.83	4.14	3.53	3.66	6.58	7.36
Coal burned per sq. ft. of grate, per hour	11.45	13.81	14.93	12.20	12.24	21.57	25.07
Draft in ins. of water	.087	.094	.174	.166	.18	.75	.81
Moisture in coal %	6.47	6.35	7.35	4.05	4.54	4.0	2.0
Refuse in coal, %	8.63	12.3	11.82	11.91	12.13	7.92	9.65
Duration of tests, hours	9:16	10:08	8:91	9:0	10:16	10:0	4:6
Date: April, 1900	18th.	19th.	20th.	21st.	23d	26th.	28th.

The boiler was run for several days before the tests, and also while the tests were being made, without cleaning the soot from the tubes. Numerous experiments were tried to determine the ability of the generator to withstand severe and unusual conditions of operation. The extremes of high and low water were tried, the pressure was dropped suddenly and the fires were forced. Large quantities of cold water were pumped in rapidly, and the fire doors were opened, allowing cold air to impinge upon the tubes. No appreciable injury resulted from this treatment. All the steam hammers have been thrown on at once, dropping the pressure suddenly as much as 20 lbs. without affecting the water level or the dryness of the steam.

The material for the illustrations accompanying this article and results of the tests above given have been furnished to us by Mr. John C. Parker, the inventor and patentee of the boiler. The latter is manufactured by the Parker Engine Co., of California, with offices in the Drexel Building, Philadelphia, Pa.

The Hammond boiler, which is shown in its essential parts in Fig. 3, has been placed on the market quite recently, but one of the boilers has been in use for six months in the works of the builders, the Hammond Iron Works, of Warren, Pa., and has given very satisfactory results.

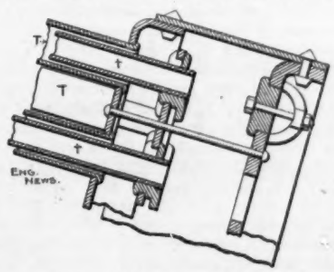


Fig. 4. Details of the Rear Header of Hammond Boiler.

In this boiler the tubes are attached to the steam drum at only one end, which arrangement leaves the tubes and drum free to expand independently of each other. The water passes from the dome through the pipe G into a chamber C in the front header, into which open the circu-

lating tubes t. These pass thruogh the length of the heating tubes T to the rear header. Here the water passes around the diaphragm D and into the annular spaces between the large and small tubes, where it is converted into steam. The steam is discharged into the compartment E in the front header and rises thence by the pipe F to the steam drum. Details of the rear header are shown in Fig. 4.

THE TALBIKSAK RIVER; A POSSIBLE SHORTENING OF THE YUKON ROUTE.

By William S. Post.*

The Yukon River has never yet appeared in the lists of River and Harbor appropriations, but any plan for the improvement of this mighty waterway is worthy of the consideration of Congress. The Yukon maintains a fleet of 100 steamboats which provide transportation for thousands of passengers annually and carry supplies to the entire gold region. The problem of the possible shortening of its navigable route possesses an engineering interest because of its simplicity and the unusual means by which it may be accomplished.

A glance at a sketch map of Alaska (Fig. 1) shows us the area to be described. Tracing the Yukon from its delta, the course upstream is east,

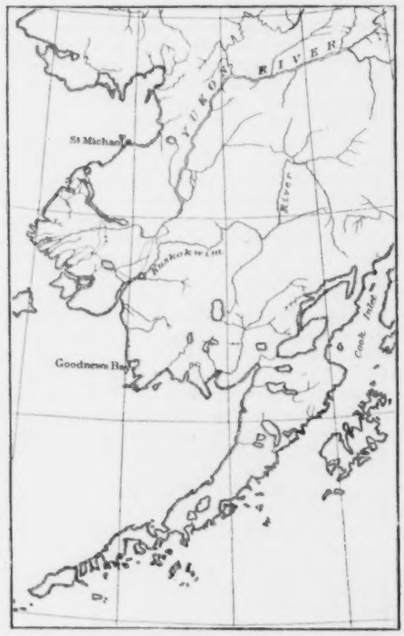


Fig. 1. Map of the Yukon Delta.

and then, turning, it gradually inclines to the north. Near this bend is the mouth of the Talbiksak River. This is a famous wintering place for steamers, for from this point they are enabled to proceed up the river immediately after the ice breaks up, while from Saint Michael's the entrance to the delta is blockaded by the lodging of the ice on the bars for a considerable time after the river is clear. It is said that steamers so wintering frequently ascend to Dawson and return before traffic at Saint Michael's is opened.

The Talbiksak River (Fig. 2) rises in the tundra, or arctic plain, and while of no great drainage area, it averages 200 ft. in width for 12 miles or more above its mouth. The current is sluggish, and the banks throughout are low. Twenty miles south in an air line from the mouth of the Talbiksak, and corresponding to that of the Yukon, lies a great bend of the Kuskokwim, a river which has received but slight mention until recent years, although in size it is second only to the Yukon, and it may in the future become of great importance upon the discovery of gold at its head. It is navigable by steamboat for 600 miles from its mouth; the current is slower than that of the Yukon, and its course is less impeded by islands. It is of interest to know that the Kuskokwim rises in the central Alaskan range; one of whose peaks, Mt. McKinley, has an elevation of 20,464 ft., the highest in North America.

During the exploration of the Kuskokwim River by a party of the U. S. Geological Survey, to which I was attached as topographer, I was impressed with the possible importance of this Kuskokwim-Yukon route. On inquiry it appeared that natives and missionaries were well aware of this route, and used it constantly in summer to reach Saint Michael's from the Kuskokwim. As it consisted of a series of streams, marshes and lakes, they were able to use canoes the entire distance with the exception of two portages of short length. Mr. Hinckley, of our party, was instructed to follow this route to Saint Michael's, and from his notes taken on this trip I compiled the following statement, which is published in the 20th Annual Report of the U. S. Geological Survey, Part VII. The accompanying map (Fig. 2) illustrates the route and the references in the statement:

The southern entrance to the route is at the native village of Kalchagamut, where a sluggish stream enters the Kuskokwim. This stream is ascended in a northwestern direction about 3 miles. Its mouth is 70 ft. wide and 3½ ft. deep; 1 mile of it is 100 ft. wide and 7 to 12 ft. deep, and it gradually narrows to 30 or 40 ft. in width in its upper course. The channel is remarkably straight and the depth uniform with banks 4 to 6 ft. high. On August 23, 1898, when the route was traveled, the current was dead, being backed up by high water in the Kuskokwim.

At the point "A" boats are pulled through a swamp and mud rut for an eighth of a mile, and are there portaged 300 ft. over a clay bank to a pond whose level is about 6 ft. higher. This pond is 150 ft. long. From here a second portage 60 ft. long is made over a clay bank 15 ft. high. Here one passes from tree growth to open tundras. After this portage boats are dragged or poled through a water rut 1,000 ft. long to Lake "B," which is 600 ft. across. The outlet of the lake is marshy, and the boats are pushed through water grass a short distance to a stream flowing northwest. This is extremely tortuous, 240 bends being noted between "B" and "C," the latter point being its junction with its eastern branch. Its usual width is 30 ft. and its depth 6 to 9 ft. The banks are not well defined, but run into swamps and ponds; the current is about 1 mile an hour.

On reaching the junction "C" the main stream is ascended. In the lower portion the banks run into swamps and ponds, while farther up they become better defined and are 6 to 10 ft. high, and the stream narrows to 25 ft. and even to 10 ft. in width. Still farther up it again widens, and the lateral swamps and ponds again replace the banks, affording numerous short cuts for canoes. From "C" to Lake "D" is about 20 miles. Lake "D" is about 3 ft. deep, and a winding stream 1 mile in length connects it with Lake Oknakluk, which is 2½ miles long and averages 4 ft. in depth, with clay bottom and flat shores.

A water rut one-half mile long extends from Lake Oknakluk into Lake "E," three-fourths mile long, and from here one paddles through water grass to the last lake, "F." At this point the tundras end and the spruce forest begins. A portage is here made over a clay bank 30 ft. high to a water rut which runs into the Yukon tributary, the Talbigsak River. This is a large, slow stream with high flood banks. It is at first 100 ft. wide and 7 ft. deep, but 12 miles farther, at its mouth, is 350 ft. wide and 14 ft. deep.

The total length of the water route and portages is 66 miles, while the air-line distance between the two rivers, the Yukon and the Kuskokwim, is only 20 miles. The highest clay or gravel bank crossed on the portages is 40 ft.

The relative elevations of the Kuskokwim and Yukon rivers have not been determined, neither has the elevation of the divide between the two been measured, but enough has been seen to warrant the possibility of opening a water route. The current of the Kuskokwim being less than that of the Yukon, the presumption is that if diverted the Yukon would flow toward the Kuskokwim. The Kuskokwim opens probably two weeks earlier than the Yukon, and the lower Bering Sea is comparatively clean of ice in the spring, while St. Michael is still blocked.

While the tributary ascended from point "C" has not been traversed in its lower course, it is probably Ankitaktuk Creek, which flows into the Kuskokwim at tide water. The engineering problem, therefore, involved in the connection of the Kuskokwim with the Yukon apparently consists of cutting through the portage between Oknakluk Lake and Talbiksak River. This would be a gravel cut several hundred feet long and 40 ft. deep in its highest point. Exact levelling alone can determine whether the Talbiksak River at this point is higher than the series of lakes and marshes and the Kuskokwim River; but it is altogether probable, because the point of diversion is at the same level as its mouth, and, as previously stated, the presumption is that the Yukon is of a higher level than the Kuskokwim.

An examination of this low tundra country suggests that all this was formerly Yukon delta, and that in making this diversion we would simply be restoring an old channel. After making the portage cut, the water should do its own work in clearing out the tortuous channels and marshes which constitute the route. This might be accomplished by temporarily damming the Talbiksak and forcing its waters towards the Kuskokwim.

The arctic locale suggests a form of dam constructed of ice. In a region where the ground is frozen below a depth of 2 ft. throughout the year, unless in contact with the waters of a stream, a small refrigerating plant could easily produce and maintain an ice dam throughout the summer. As soon as a channel was established the obstruction could be removed. The waters of the Yukon would also find their way through the channel, at first only during high water and ice blocades on the Yukon, but ultimately as the channel increased in depth and width a large part of the river would seek this shorter route to the sea.

Fig. 2. Map of Water-Route Between Yukon and Kuskokwim Rivers.

The port of the Kuskokwim, Goodnews Bay, lies 30 miles south of the mouth of the river, and is reported to be land-locked, of good depth and anchorage. River steamers would have to depart from here. The mouth of the Kuskokwim is famous for its immense mud flats and its great breadth. While at high tide navigation is feasible over its whole extent, it is only through one of its numerous channels which become so plainly marked at low tide that river steamers of over 4 ft. draft could ply.

I gave in the Report above referred to an analysis of the saving in distance from Unimak Pass, through which all Bering Sea steamers must sail, as follows:

Yukon route:		
Unimak Pass to Saint Michaels	720	
Saint Michaels to Talbiksak River	250	970
Kuskokwim route:		
Unimak Pass to Goodnews Bay	360	
Goodnews Bay to Kalchagamut	230	
Kalchagamut to Talbiksak River	60	650
Difference in favor of Kuskokwim route		320

The advantages of the Kuskokwim route may, therefore, be stated to be the saving of 320 miles of water navigation, the ascending of the Yukon two weeks earlier than from Saint Michael's, and the avoidance of navigation in the most dreaded part of Bering Sea.

*Superintendent Ventura Water, Light & Power Co., Ventura, Cal.